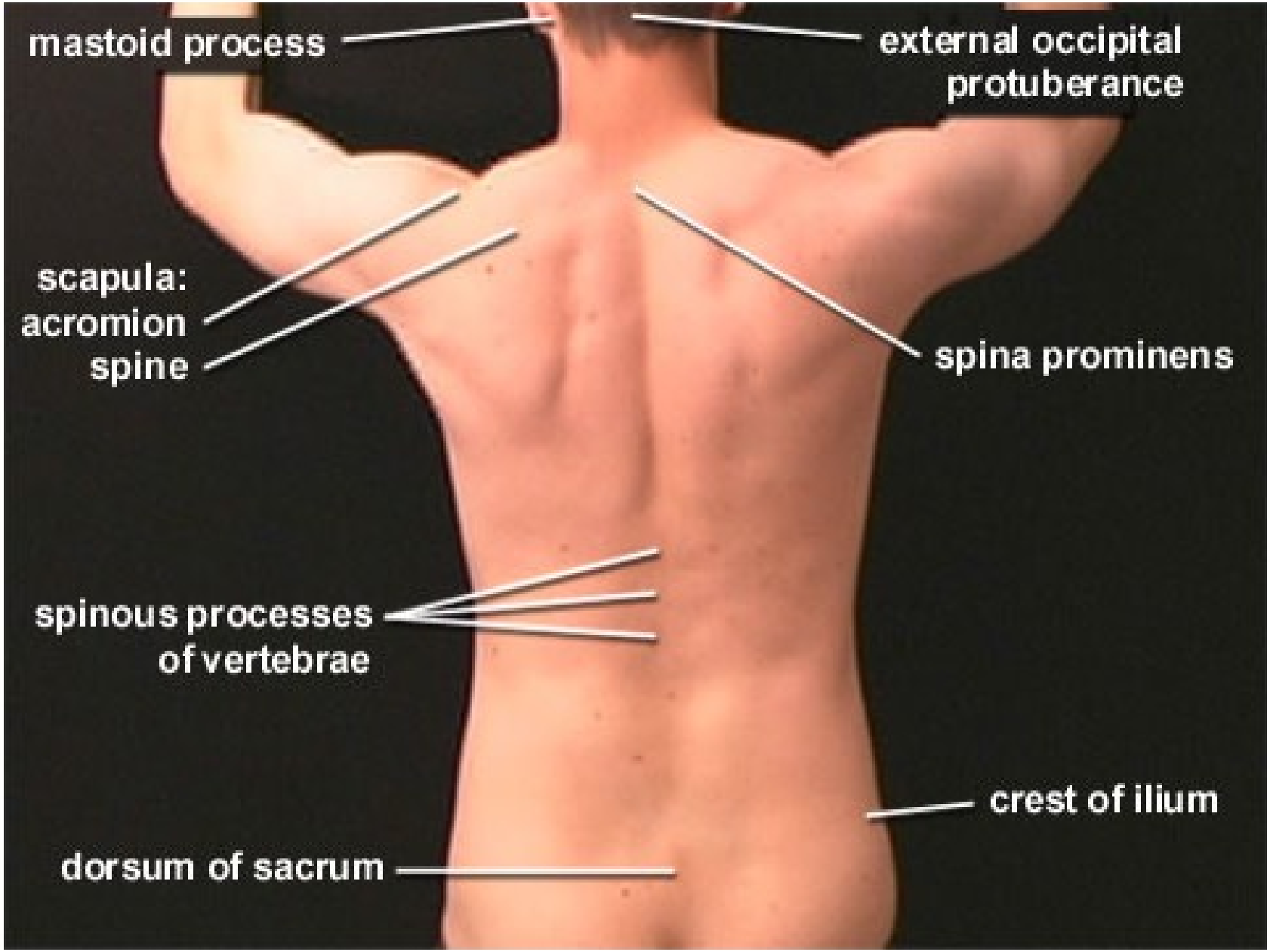
TRUNK MUSCLES: BACK

Surface Anatomy: Back

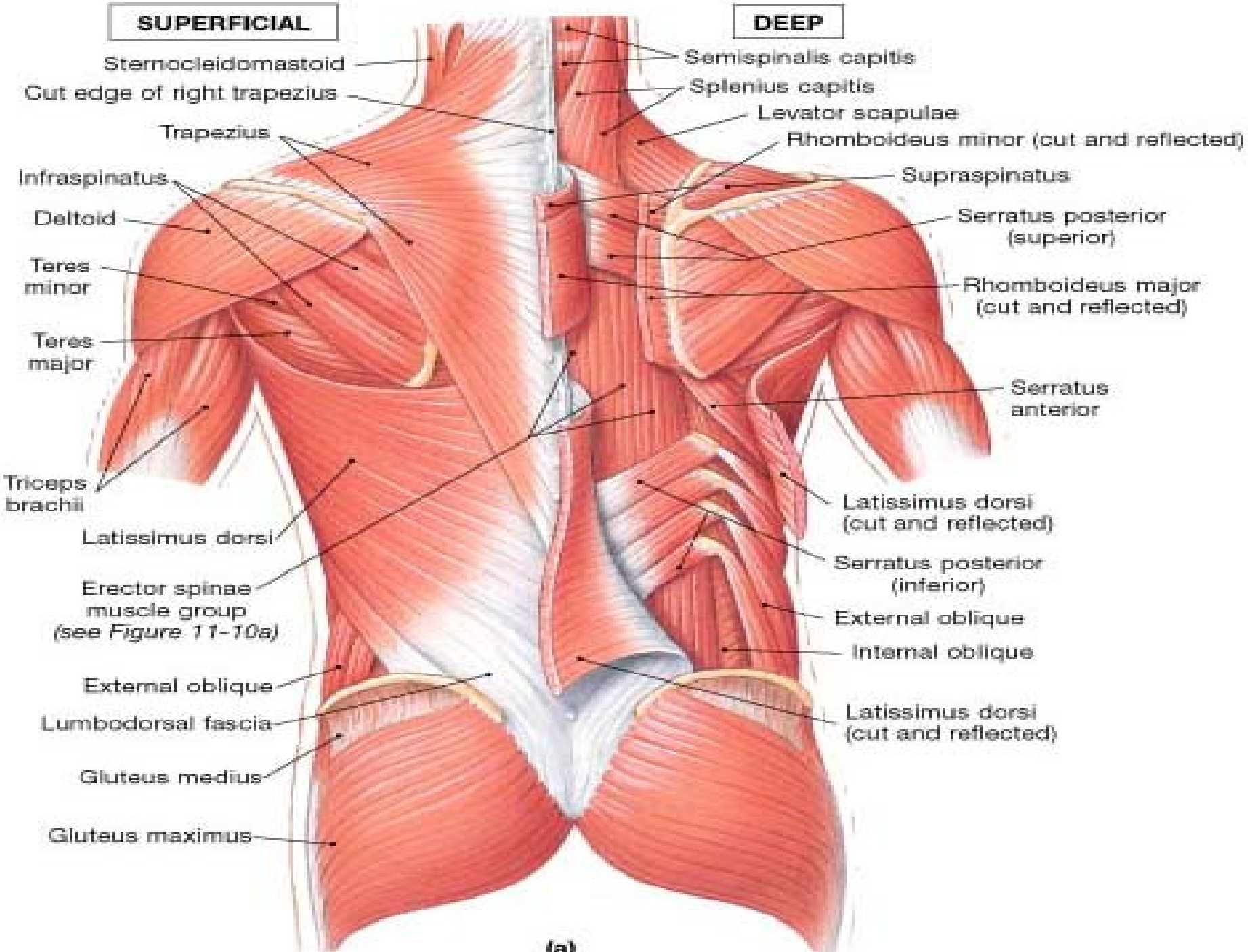


Superficial Muscles of the Anterior & Posterior Thorax

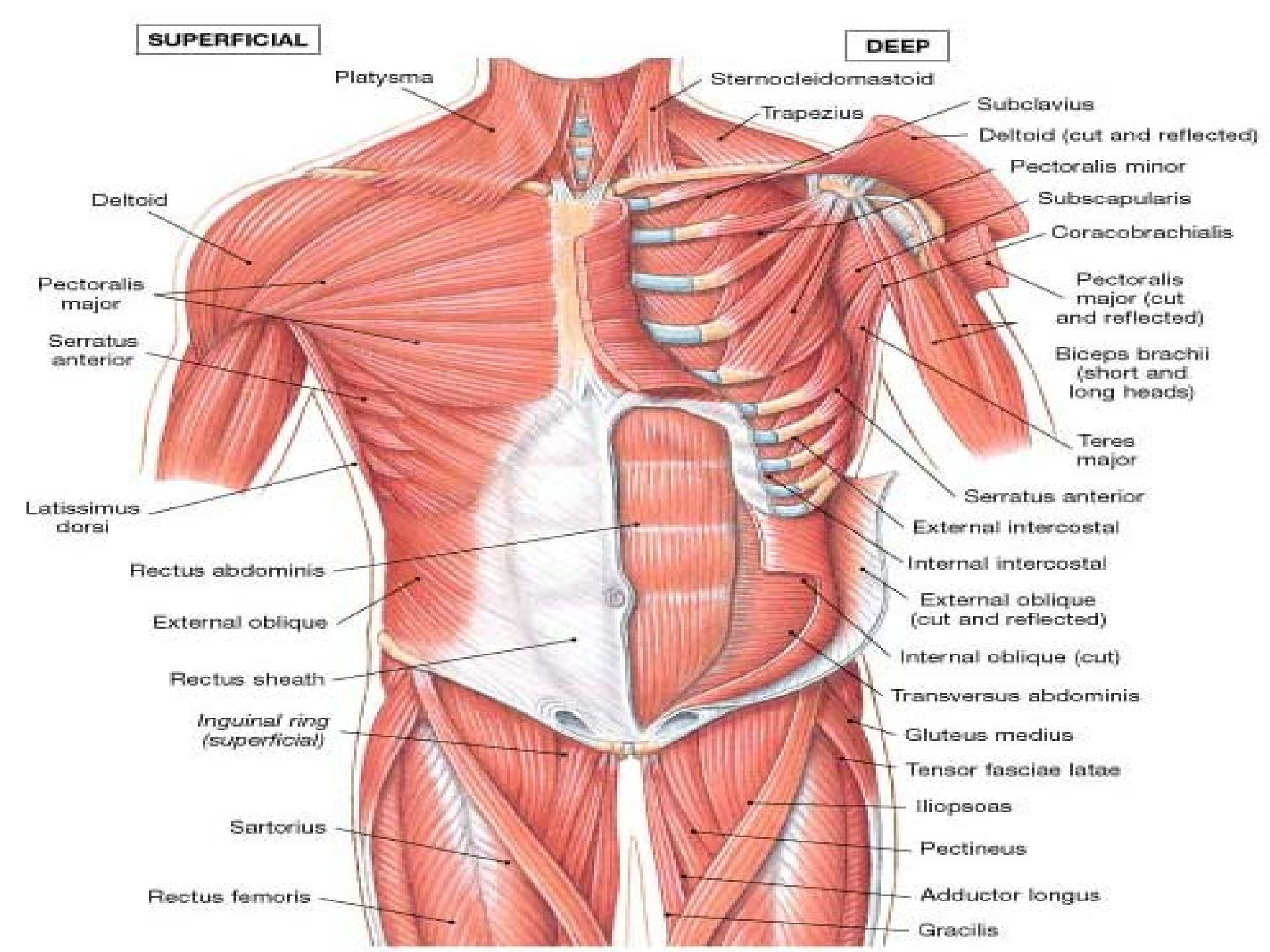
- Most superficial thorax muscles are *extrinsic shoulder muscles*
- Insertion - on the ribs and vertebrae
- Origin - on the shoulder girdle
- Action - to fix the scapula to the wall of the thorax or move the scapula to effect arm movement

Extrinsic Muscles of the Posterior Thorax

- Trapezius
- Levator scapulae
- Rhomboids major & minor


SUPERFICIAL
DEEP
Sternocleidomastoid
Cut edge of right trapezius
Trapezius
Infraspinatus
Deltoid
Teres minor
Teres major
Triceps brachii
Latissimus dorsi
Erector spinae muscle group (see Figure 11–10a)
External oblique
Lumbodorsal fascia
Gluteus medius
Gluteus maximus
Semispinalis capitis
Splenius capitis
Levator scapulae
Rhomboideus minor (cut and reflected)
Supraspinatus
Serratus posterior (superior)
Rhomboideus major (cut and reflected)
Serratus anterior
Latissimus dorsi (cut and reflected)
Serratus posterior (inferior)
External oblique
Internal oblique
Latissimus dorsi (cut and reflected)

(a)


SUPERFICIAL
DEEP
Platysma
Sternocleidomastoid
Trapezius
Subclavius
Deltoid (cut and reflected)
Pectoralis minor
Subscapularis
Coracobrachialis
Deltoid
Pectoralis major
Pectoralis major (cut and reflected)
Serratus anterior
Biceps brachii (short and long heads)
Teres major
Latissimus dorsi
Serratus anterior
External intercostal
Internal intercostal
Rectus abdominis
External oblique (cut and reflected)
External oblique
Internal oblique (cut)
Rectus sheath
Transversus abdominis
Inguinal ring (superficial)
Gluteus medius
Tensor fasciae latae
Iliopsoas
Sartorius
Pectineus
Rectus femoris
Adductor longus
Gracilis

Muscles Crossing the Shoulder Joint: Movement of the Arm

- Of the nine muscles, only the superficial:
  - Pectoralis major
  - Latissimus dorsi
  - Deltoid

  are prime movers of arm movement.

Muscles Crossing the Shoulder Joint: Movement of the Arm

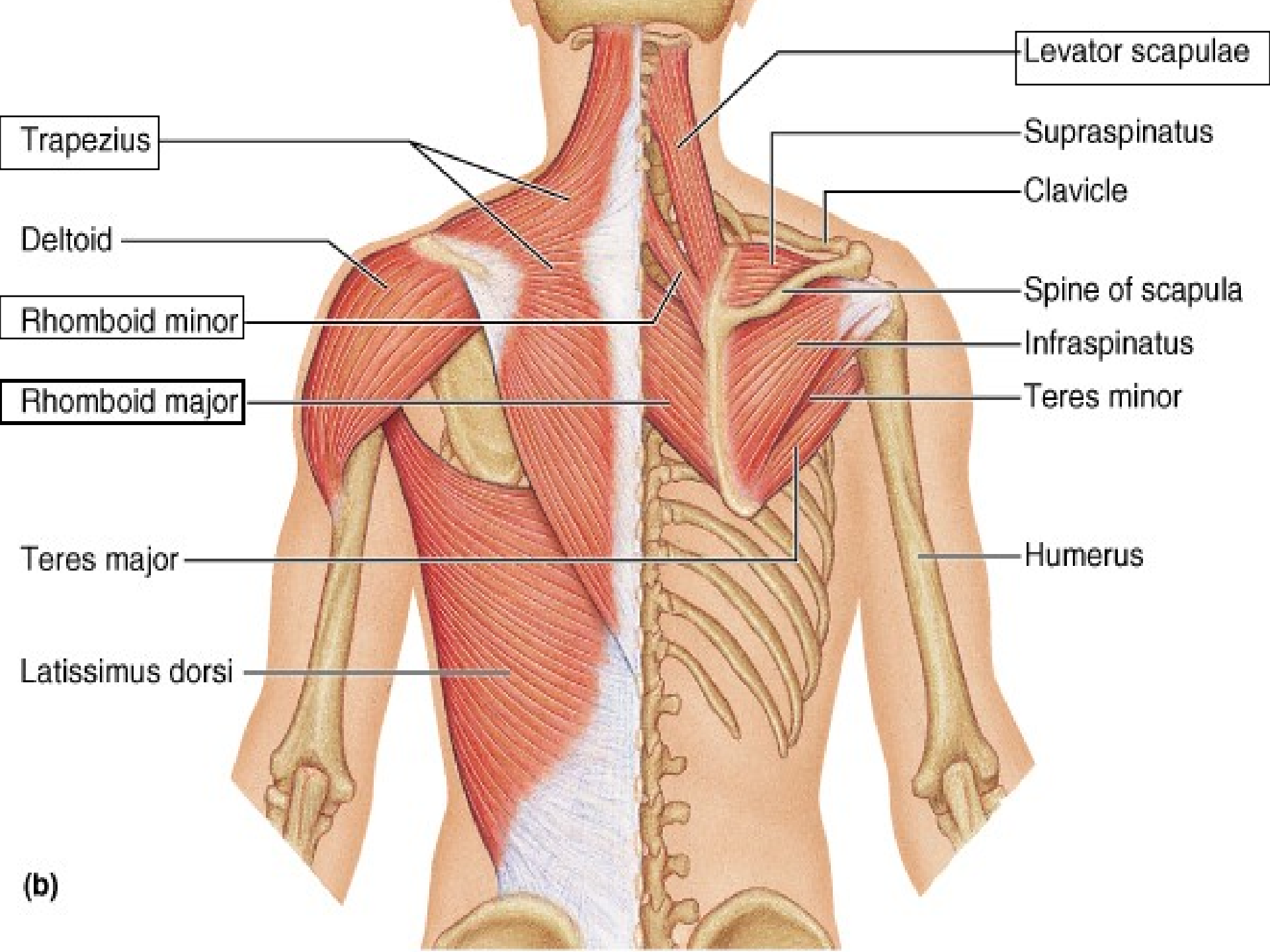
- Four muscles:
  - supraspinatus
  - infraspinatus
  - teres minor
  - subscapularis

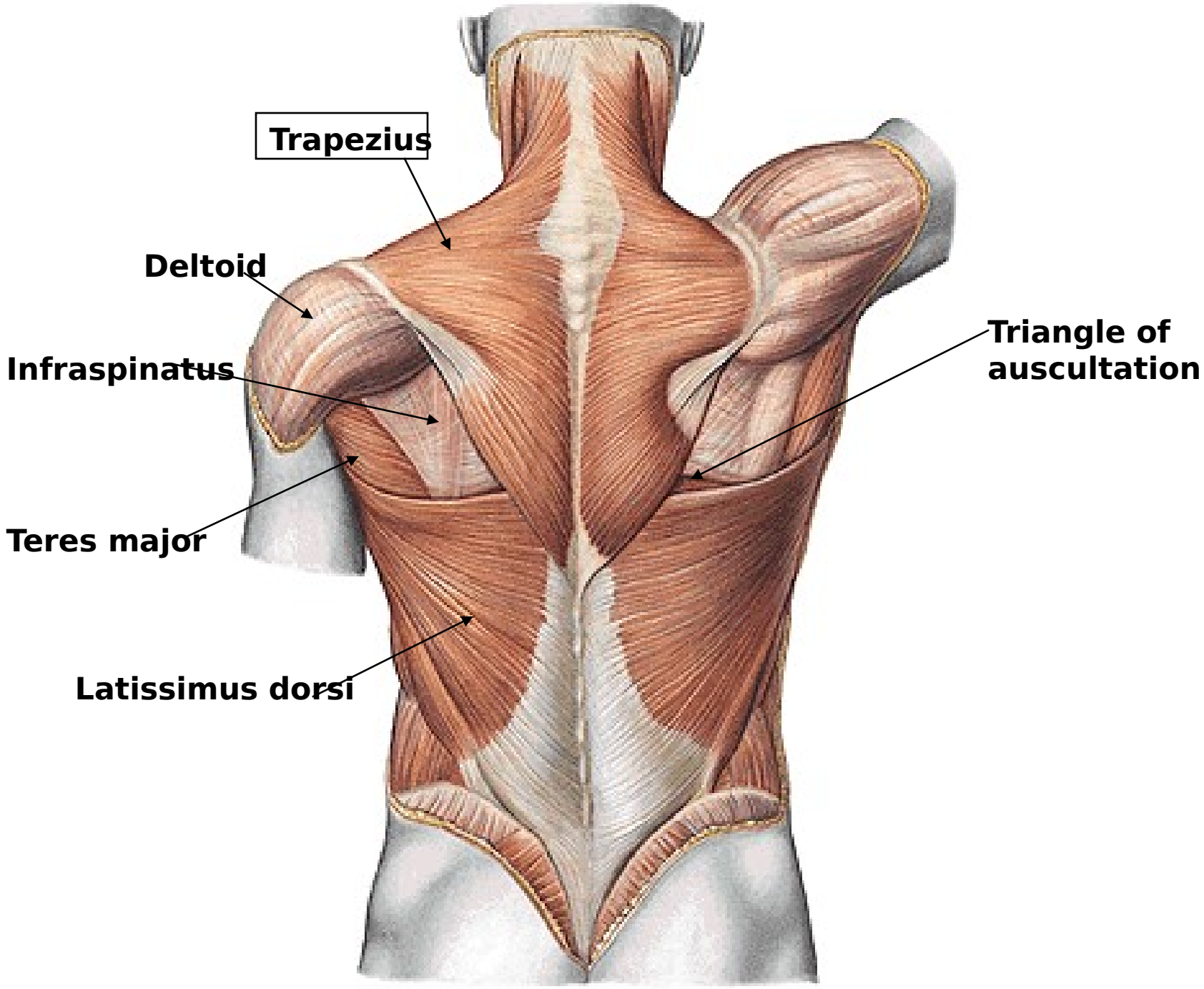
  are rotator cuff muscles.

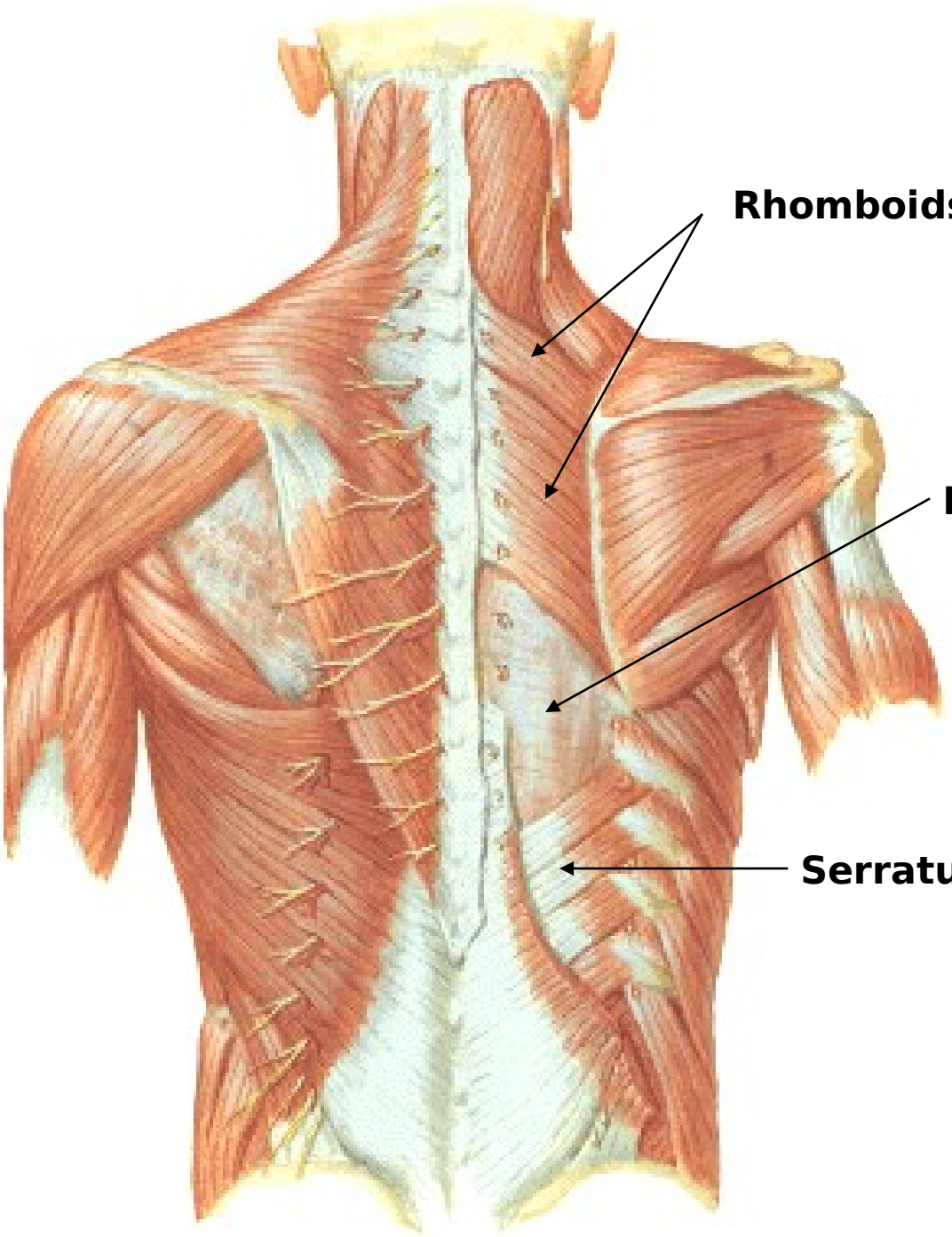
Muscles Crossing the Shoulder Joint: Movement of the Arm

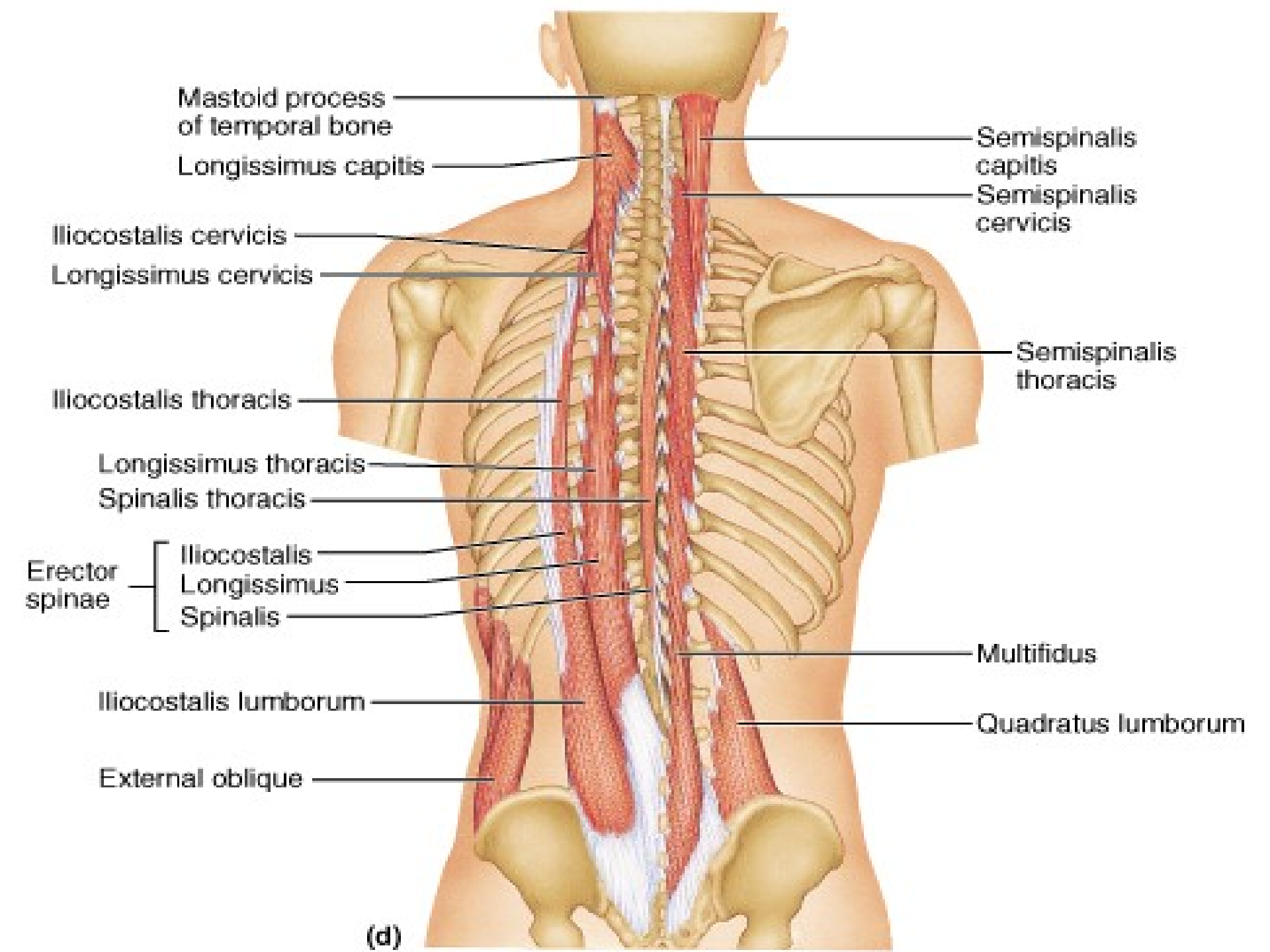
- The two remaining muscles:
  - teres major
  - coracobrachialis

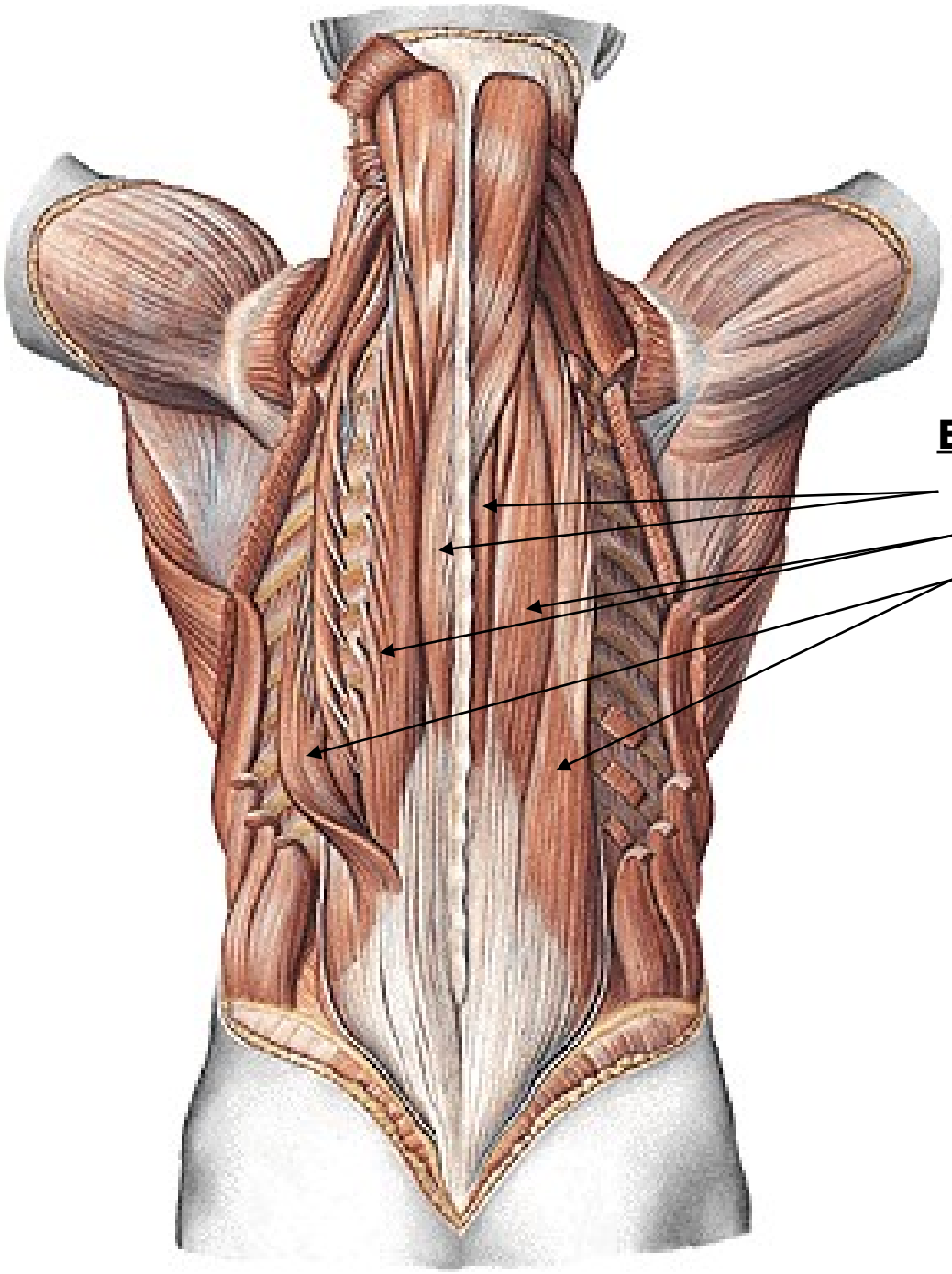
  crosses the shoulder joint but insert on to the humerus to move the upper arm.


Levator scapulae
Trapezius
Supraspinatus
Clavicle
Deltoid
Spine of scapula
Rhomboid minor
Infraspinatus
Rhomboid major
Teres minor
Teres major
Humerus
Latissimus dorsi
(b)


Trapezius
Deltoid
Infraspinatus
Teres major
Latissimus dorsi
Triangle of auscultation

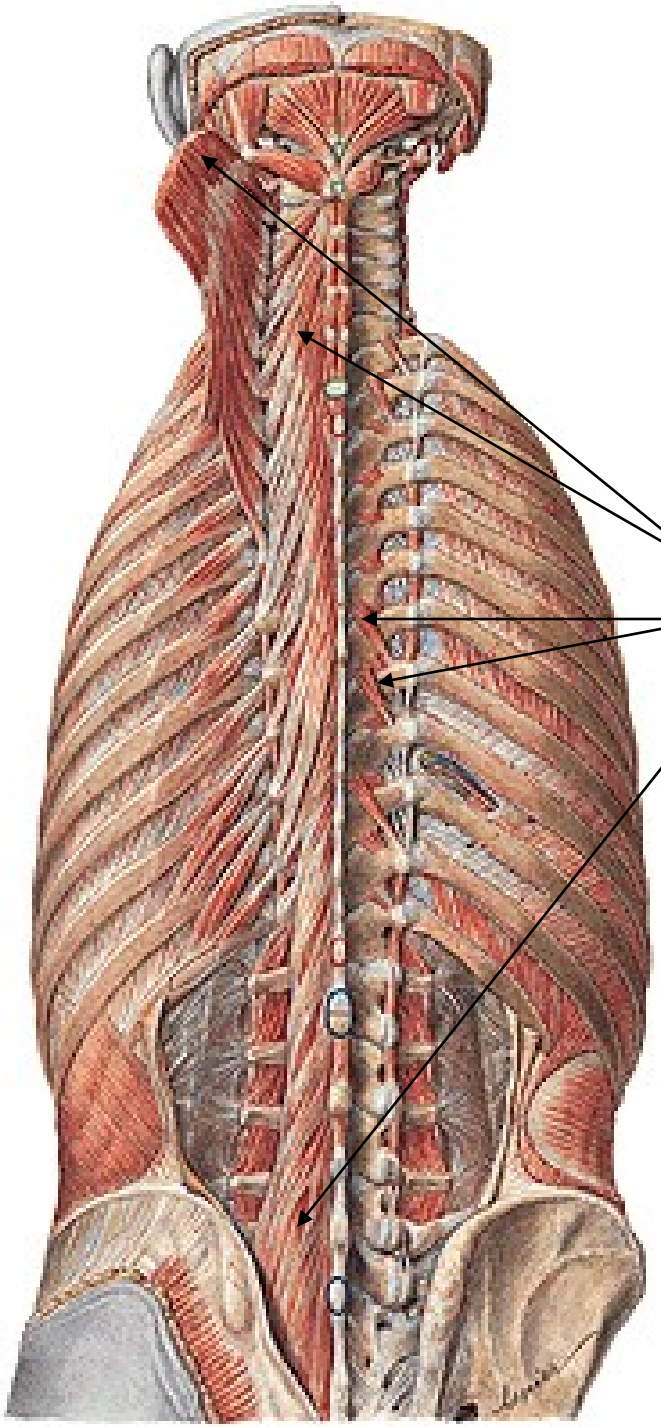

Rhomboids minor & major
Deep back muscle
Serratus posterior (inferi


Mastoid process of temporal bone
Longissimus capitis
Iliocostalis cervicis
Longissimus cervicis
Iliocostalis thoracis
Longissimus thoracis
Spinalis thoracis
Erector spinae
Iliocostalis
Longissimus
Spinalis
Iliocostalis lumborum
External oblique
Semispinalis capitis
Semispinalis cervicis
Semispinalis thoracis
Multifidus
Quadratus lumborum
(d)


Erector spinae colun
1) Spinalis
2) Longissimus
3) Iliocostalis

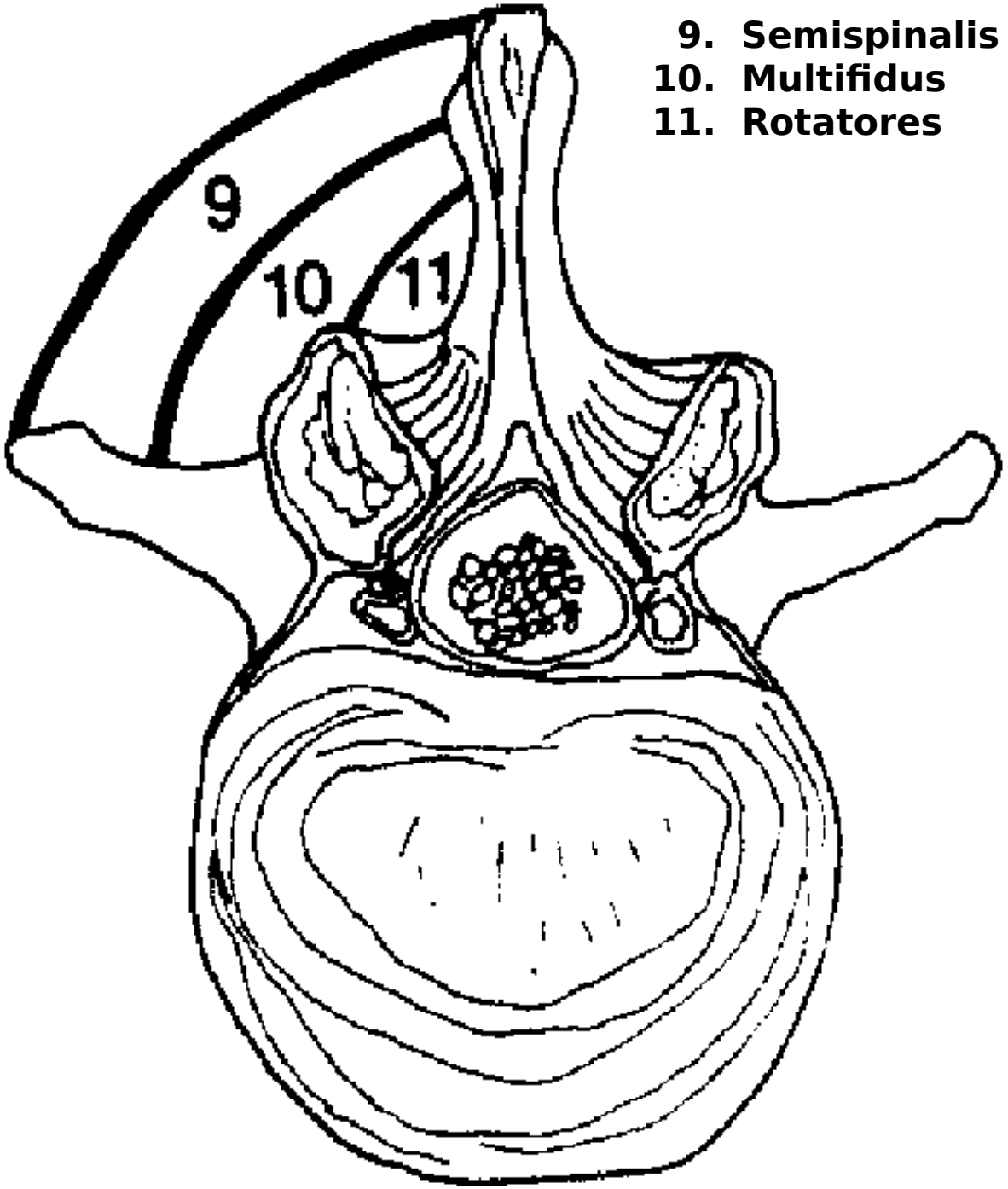
DEEP (INTRINSIC) MUSCLES

- Erector spinae group
  - Iliocostalis m
  - Longissimus m
  - Spinalis m
- Transversospinalis group
  - Semispinalis m
  - Multifidus m
  - Rotatores m



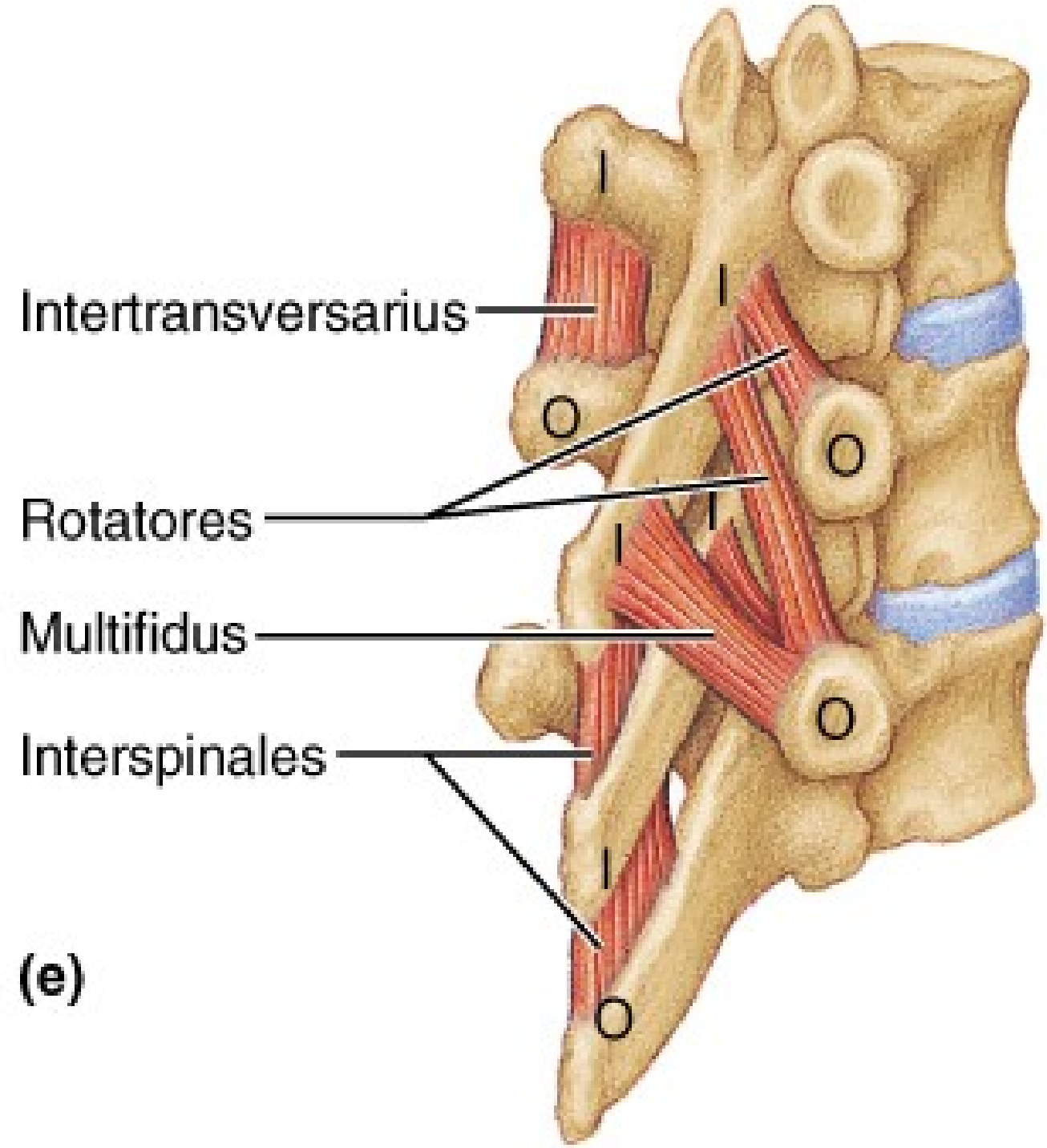
Transversospinalis group

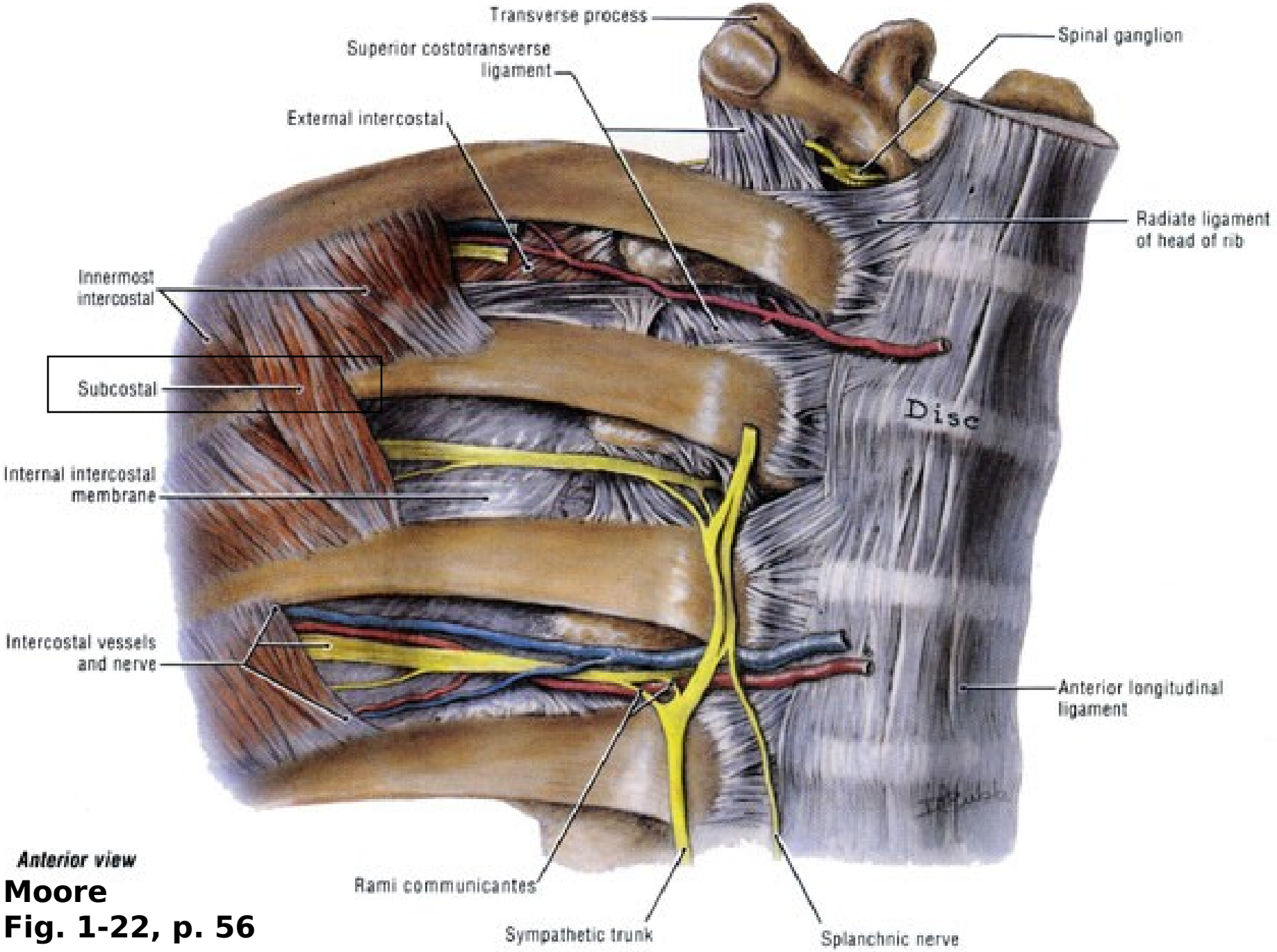
1) Semispinalis
2) Rotatores
3) Multifidus



9. Semispinalis
10. Multifidus
11. Rotatores

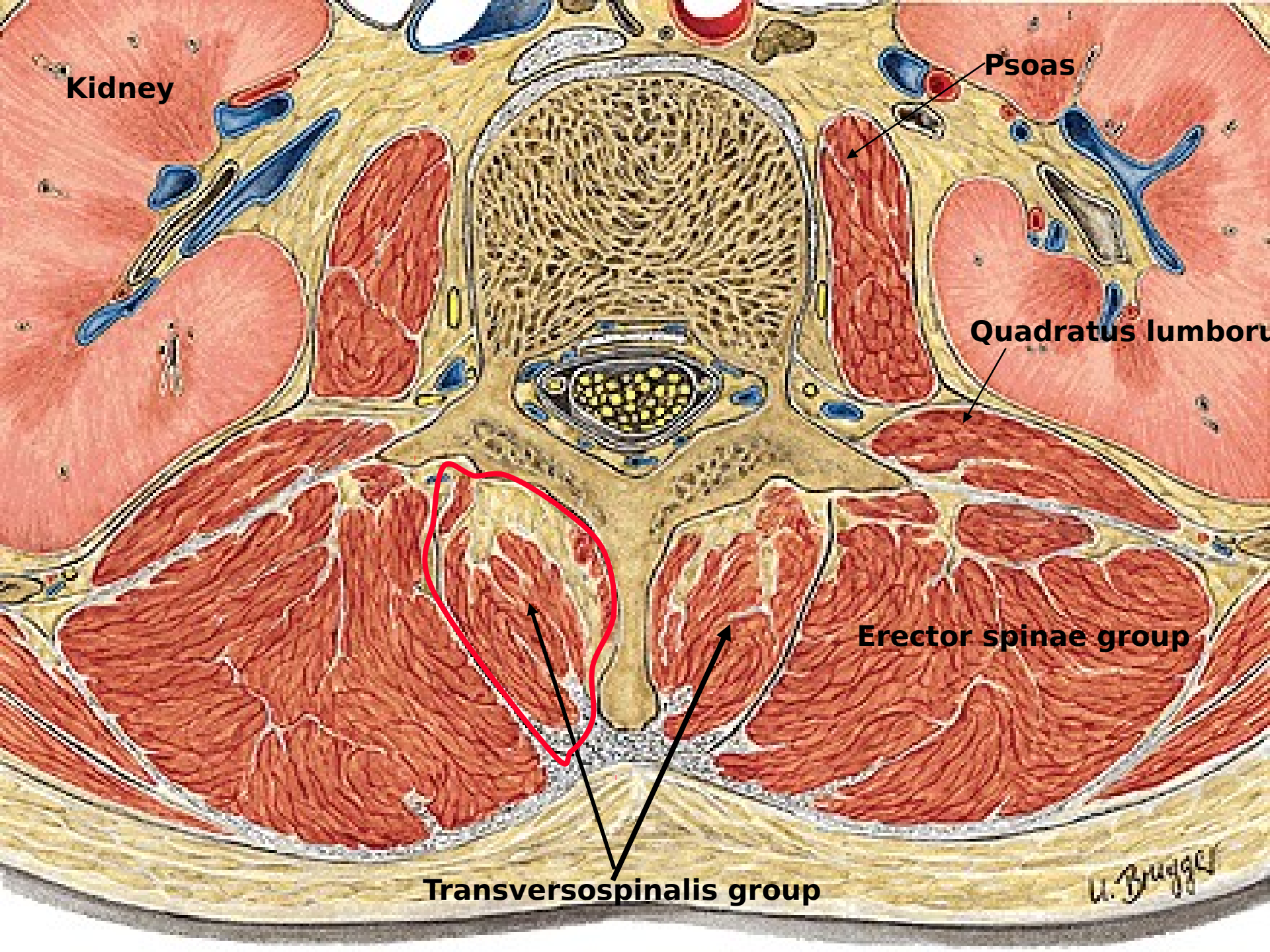
O = origin
I = insertion

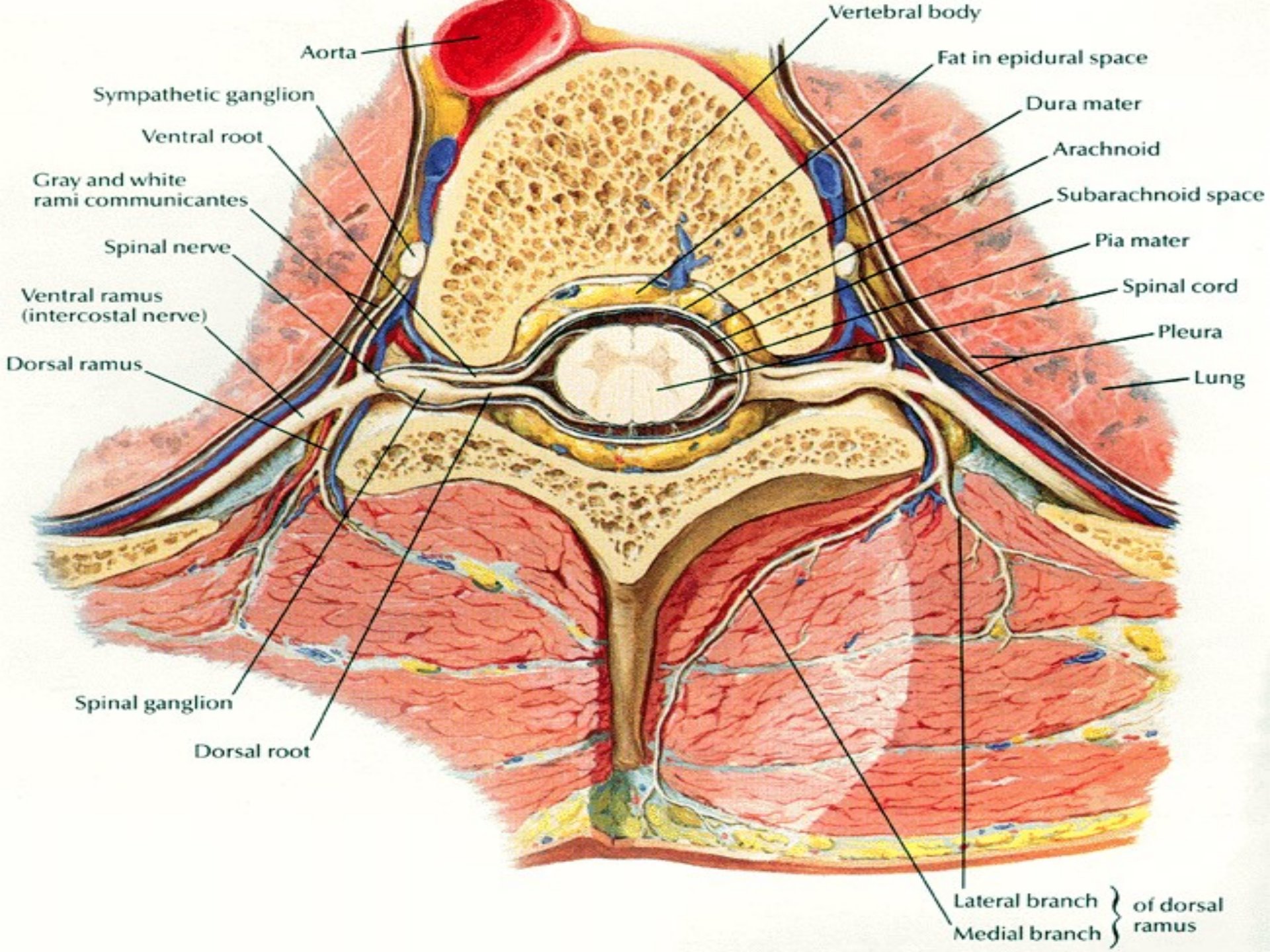




Anterior view

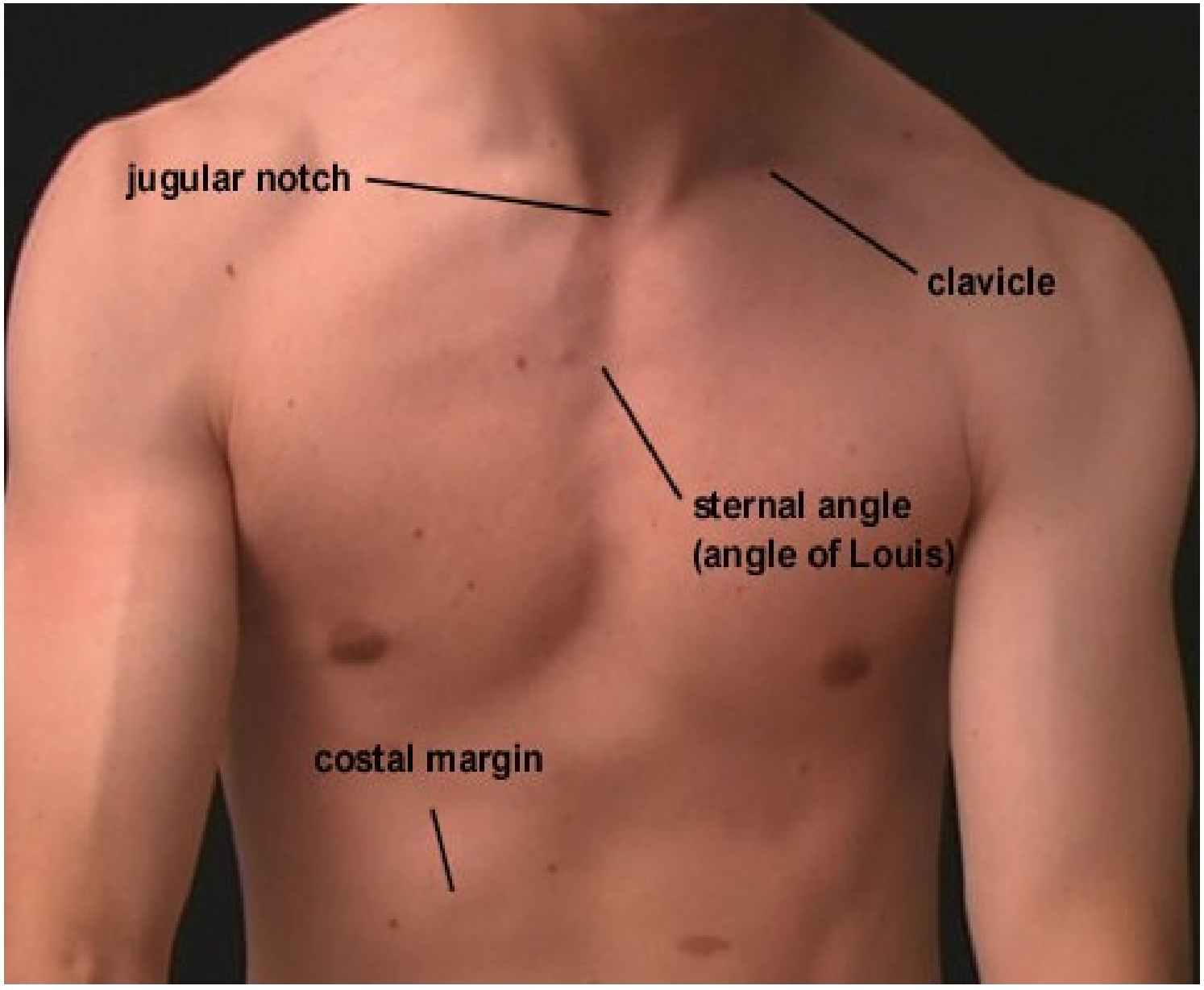
Moore
Fig. 1-22, p. 56

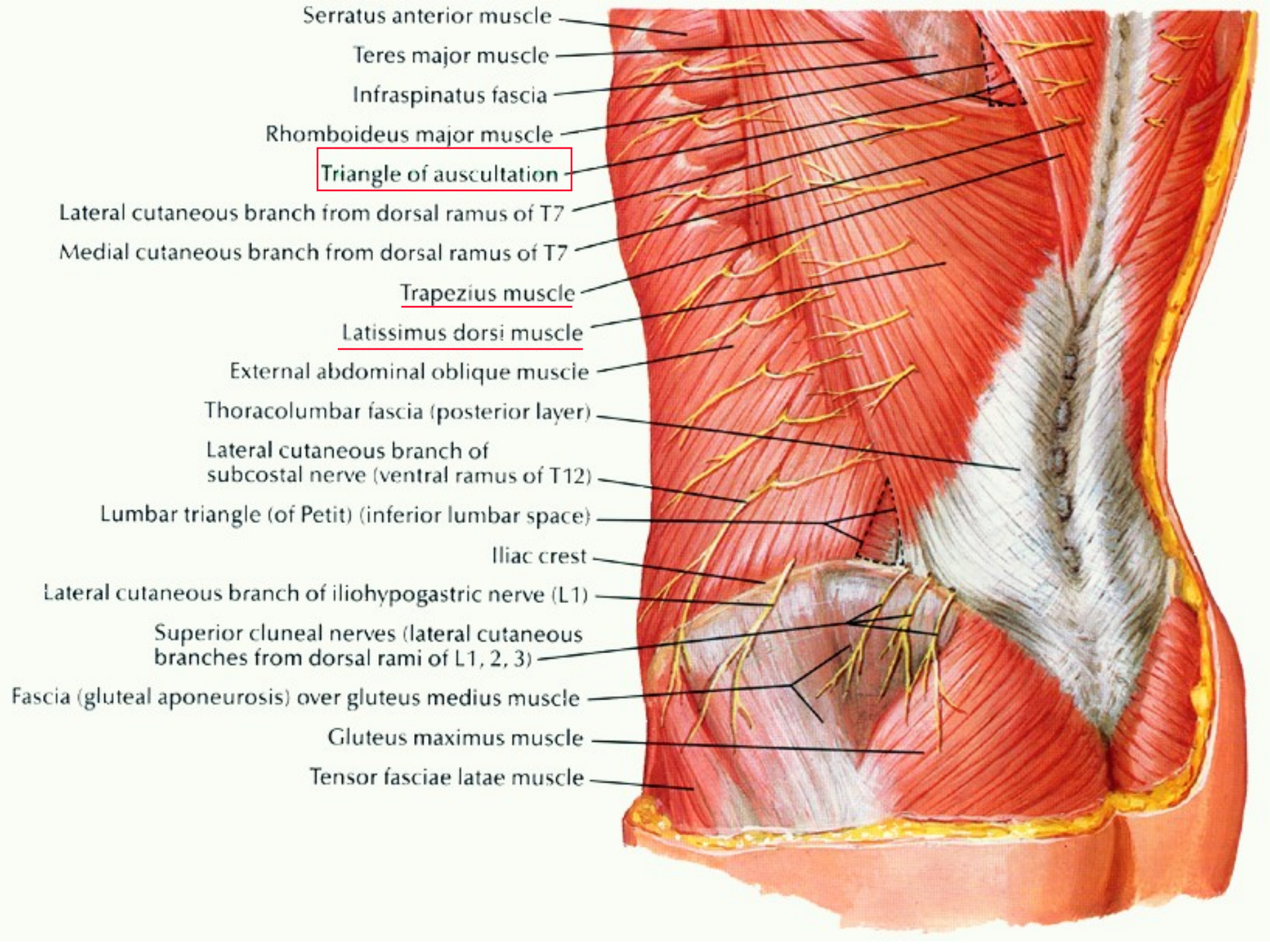

Kidney
Psoas
Quadratus lumboru
Erector spinae group
Transversospinalis group


Vertebral body
Aorta
Fat in epidural space
Sympathetic ganglion
Dura mater
Ventral root
Arachnoid
Gray and white rami communicantes
Subarachnoid space
Spinal nerve
Pia mater
Ventral ramus (intercostal nerve)
Spinal cord
Dorsal ramus
Pleura
Lung
Spinal ganglion
Dorsal root
Lateral branch
Medial branch
of dorsal ramus

TRUNK MUSCLES: THORAX

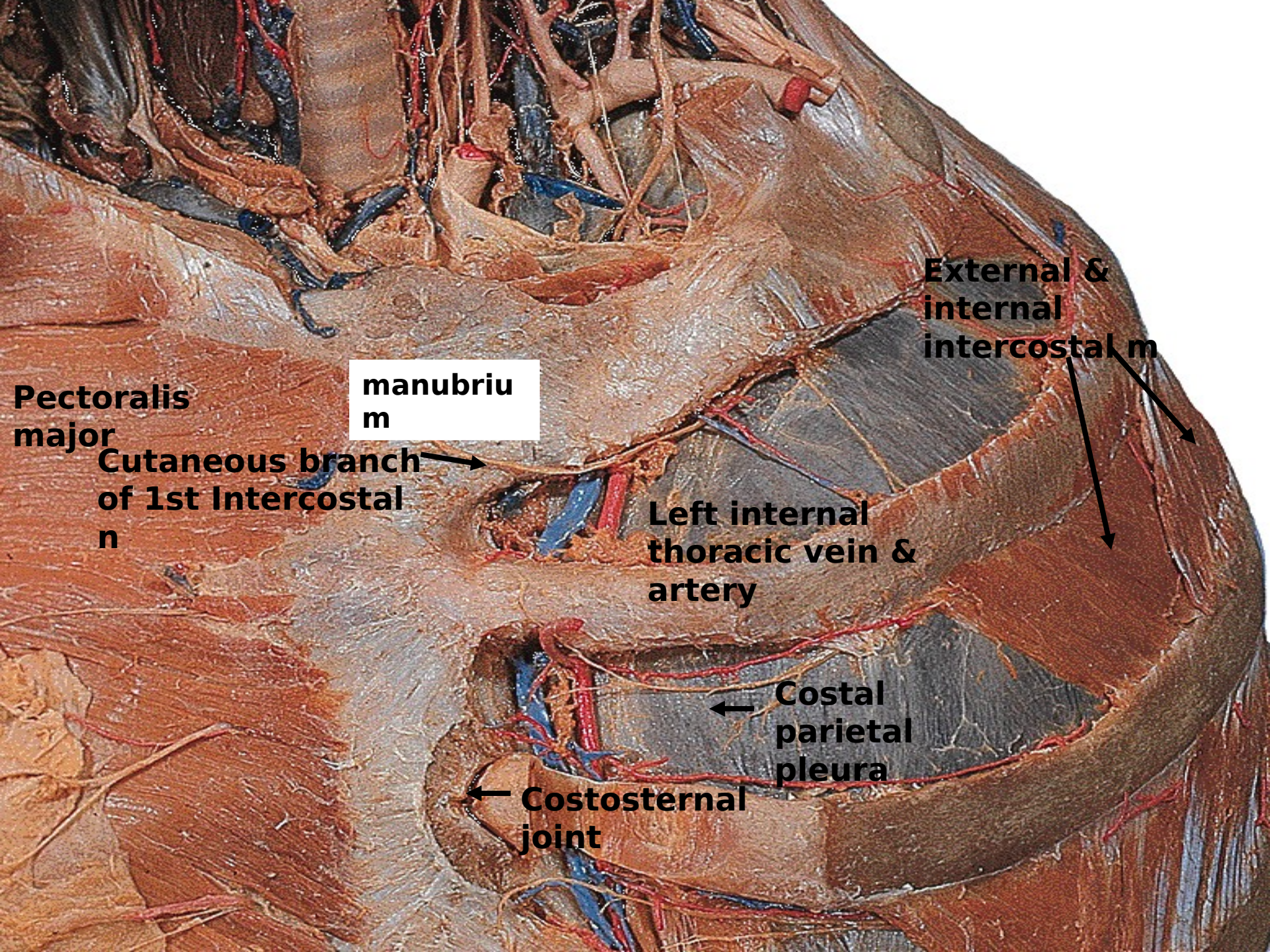
Surface Anatomy: Thorax

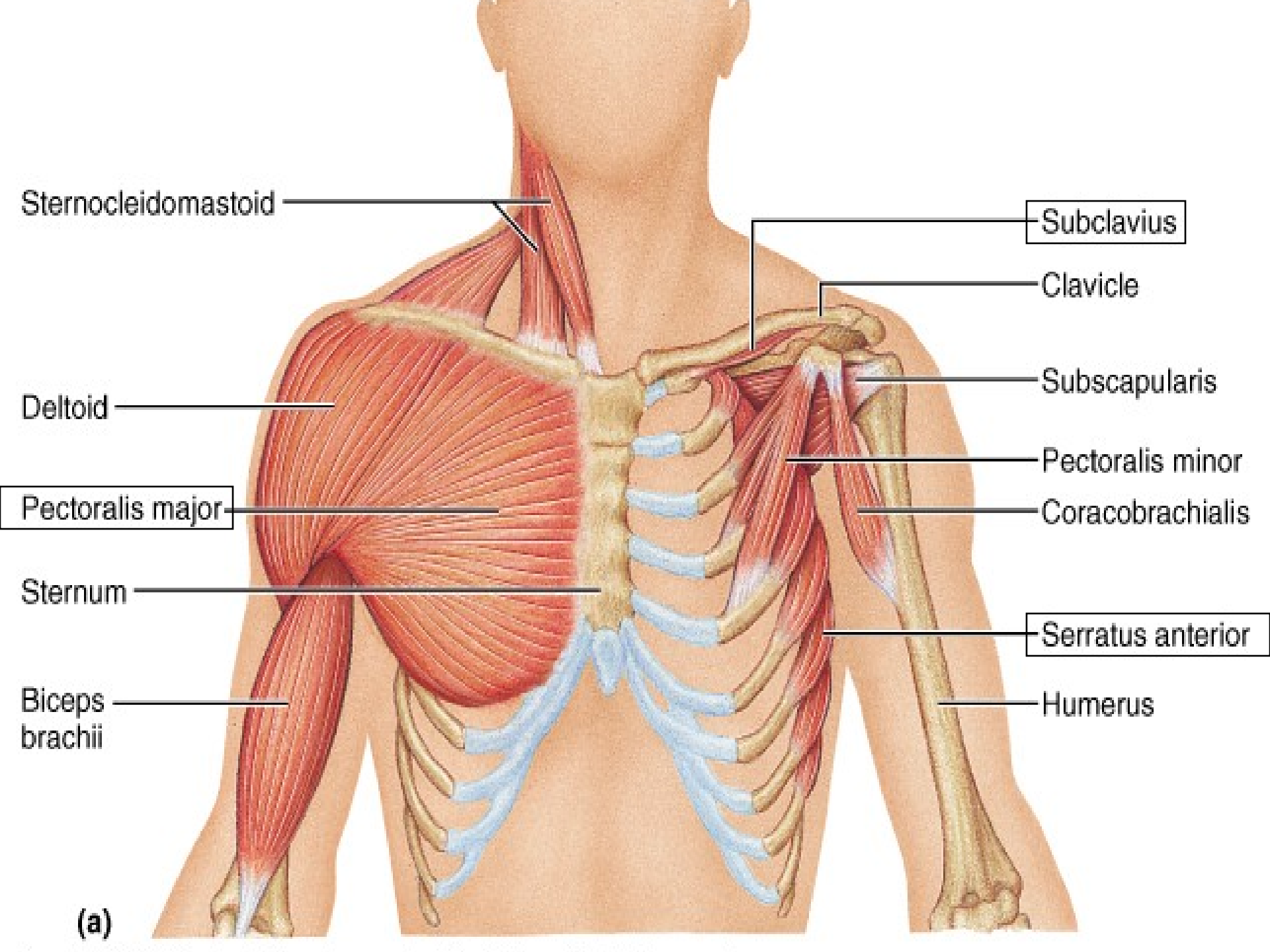


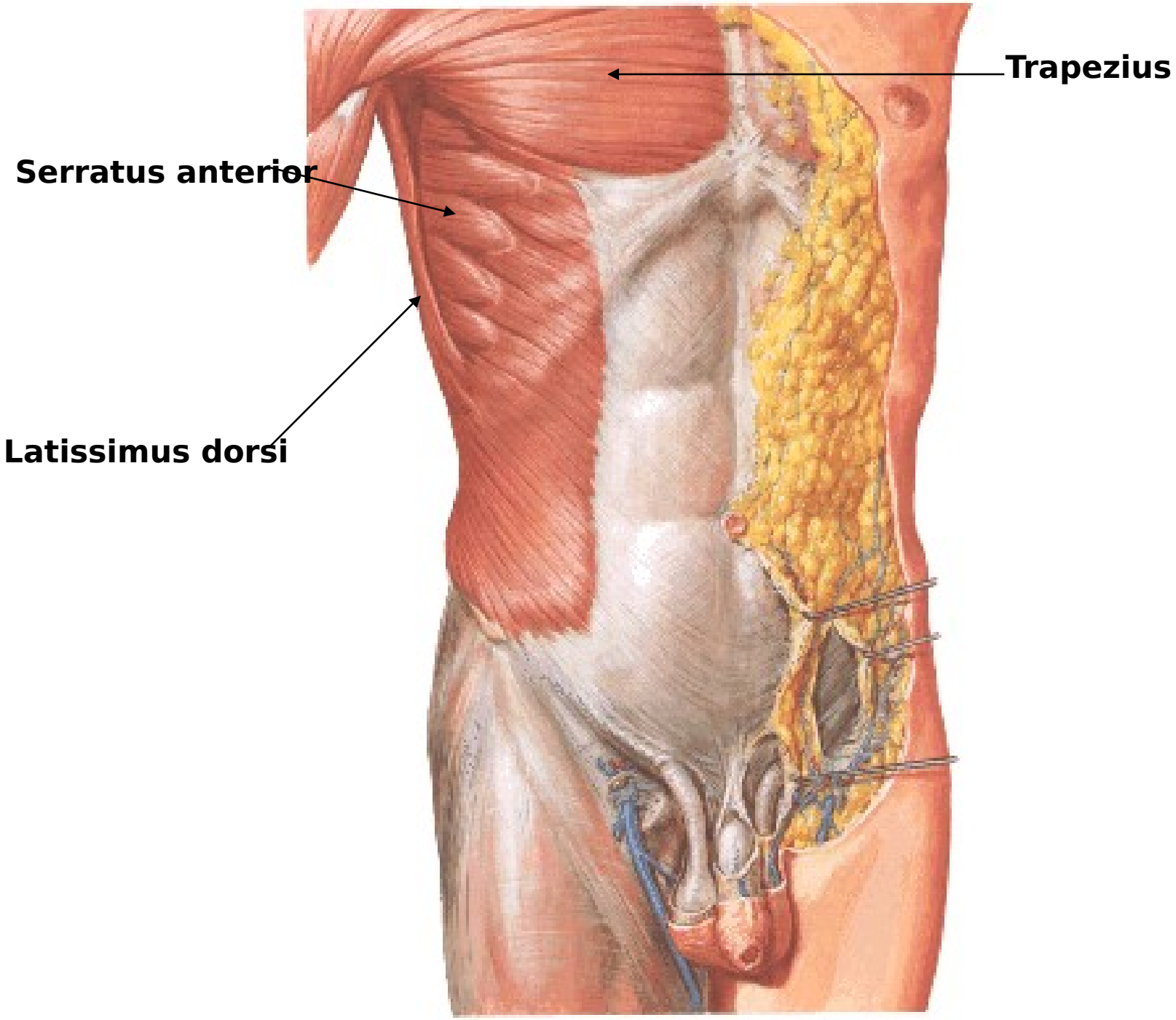

Serratus anterior muscle
Teres major muscle
Infraspinatus fascia
Rhomboideus major muscle
Triangle of auscultation
Lateral cutaneous branch from dorsal ramus of T7
Medial cutaneous branch from dorsal ramus of T7
Trapezius muscle
Latissimus dorsi muscle
External abdominal oblique muscle
Thoracolumbar fascia (posterior layer)
Lateral cutaneous branch of subcostal nerve (ventral ramus of T12)
Lumbar triangle (of Petit) (inferior lumbar space)
Iliac crest
Lateral cutaneous branch of iliohypogastric nerve (L1)
Superior cluneal nerves (lateral cutaneous branches from dorsal rami of L1, 2, 3)
Fascia (gluteal aponeurosis) over gluteus medius muscle
Gluteus maximus muscle
Tensor fasciae latae muscle

Extrinsic Muscles of the Anterior Thorax

- Pectoralis major & minor
- Serratus anterior
- Subclavius

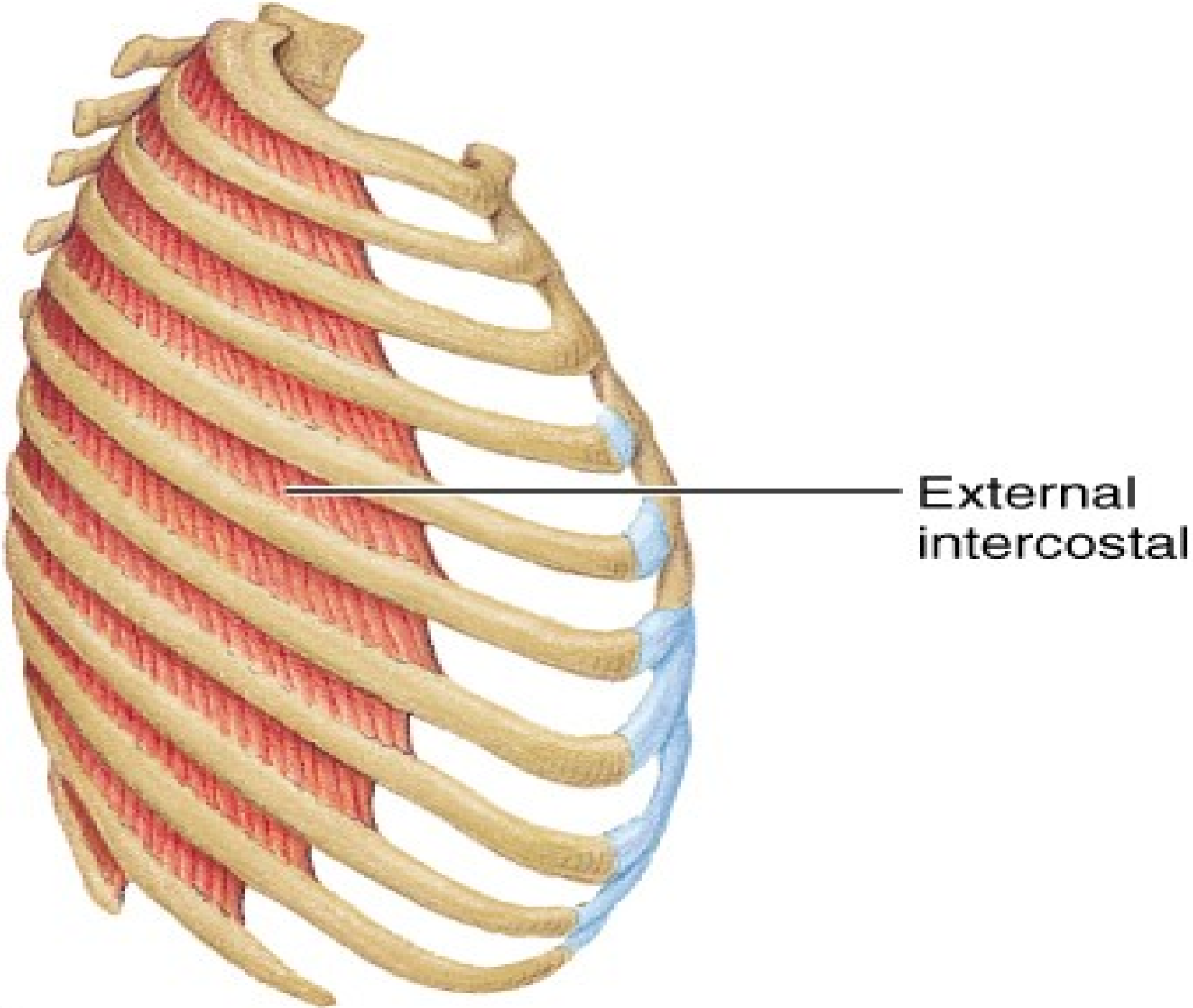

External & internal intercostal m
manubrium
Pectoralis major
Cutaneous branch of 1st Intercostal n
Left internal thoracic vein & artery
Costal parietal pleura
Costosternal joint

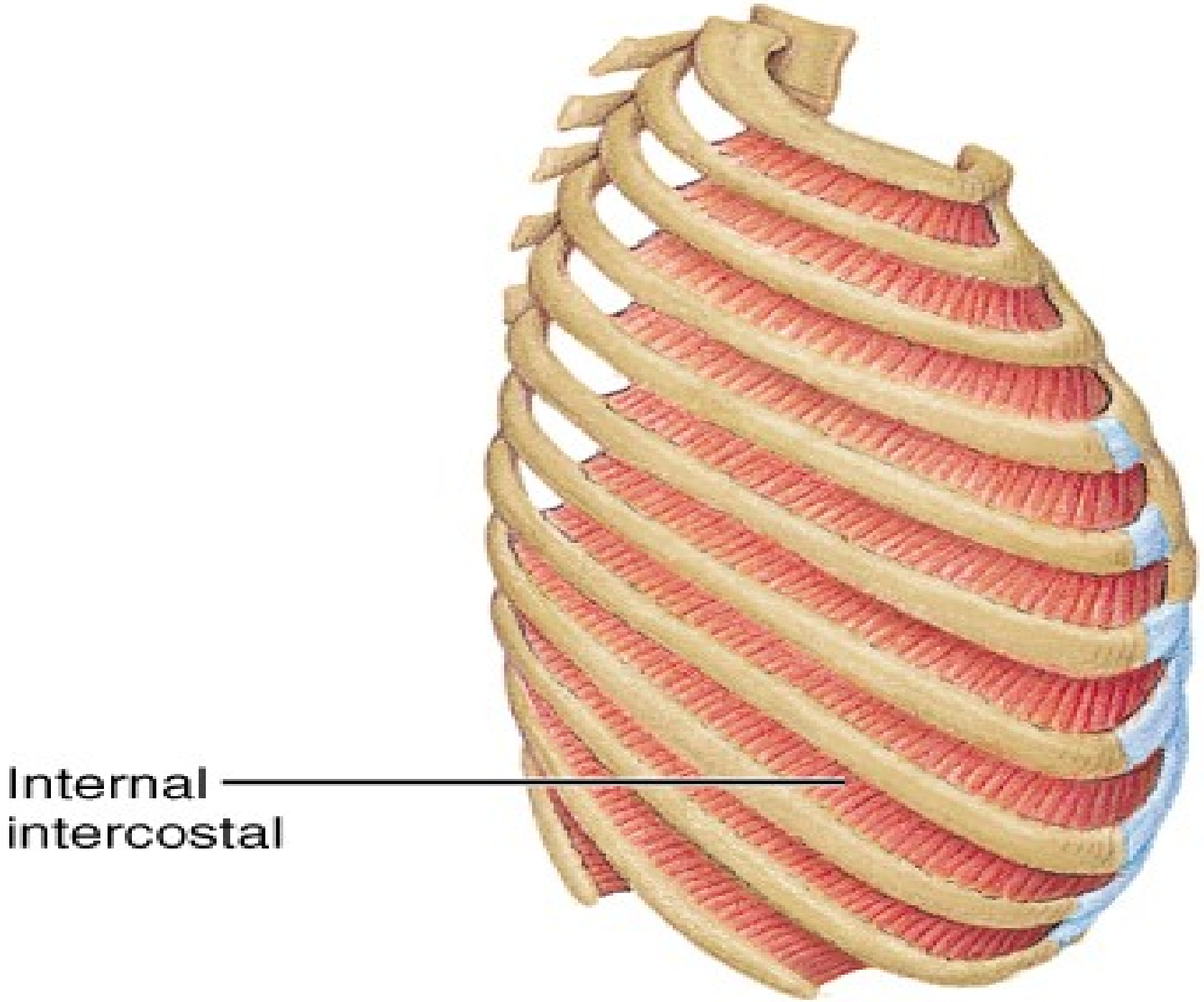

Sternocleidomastoid
Deltoid
Pectoralis major
Sternum
Biceps brachii
Subclavius
Clavicle
Subscapularis
Pectoralis minor
Coracobrachialis
Serratus anterior
Humerus
(a)

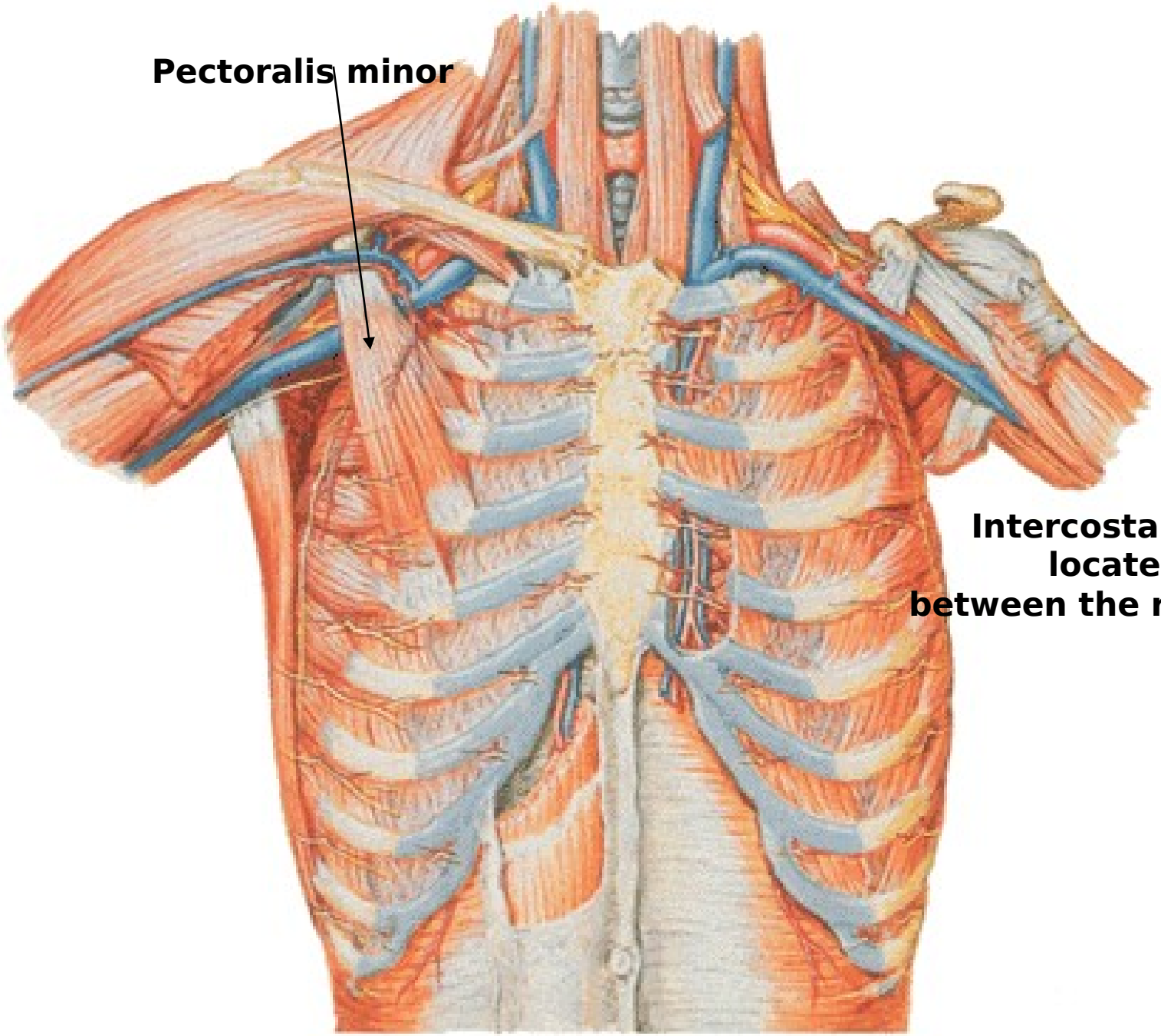

Trapezius
Serratus anterior
Latissimus dorsi

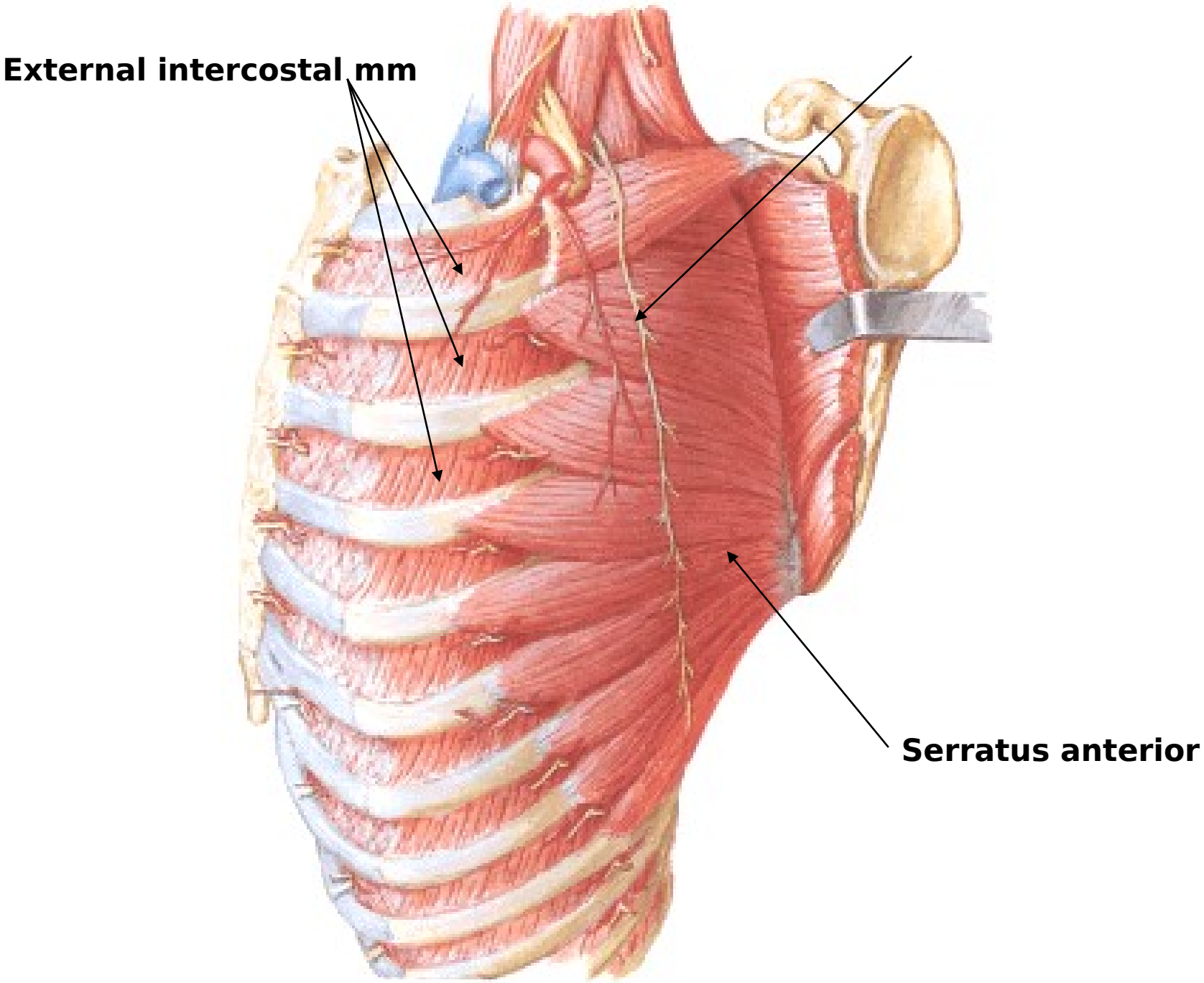
INTERCOSTAL MUSCLES

- External intercostal m
- Internal intercostal m
- Innermost intercostal m
- Transversus thoracis m
- Subcostal m

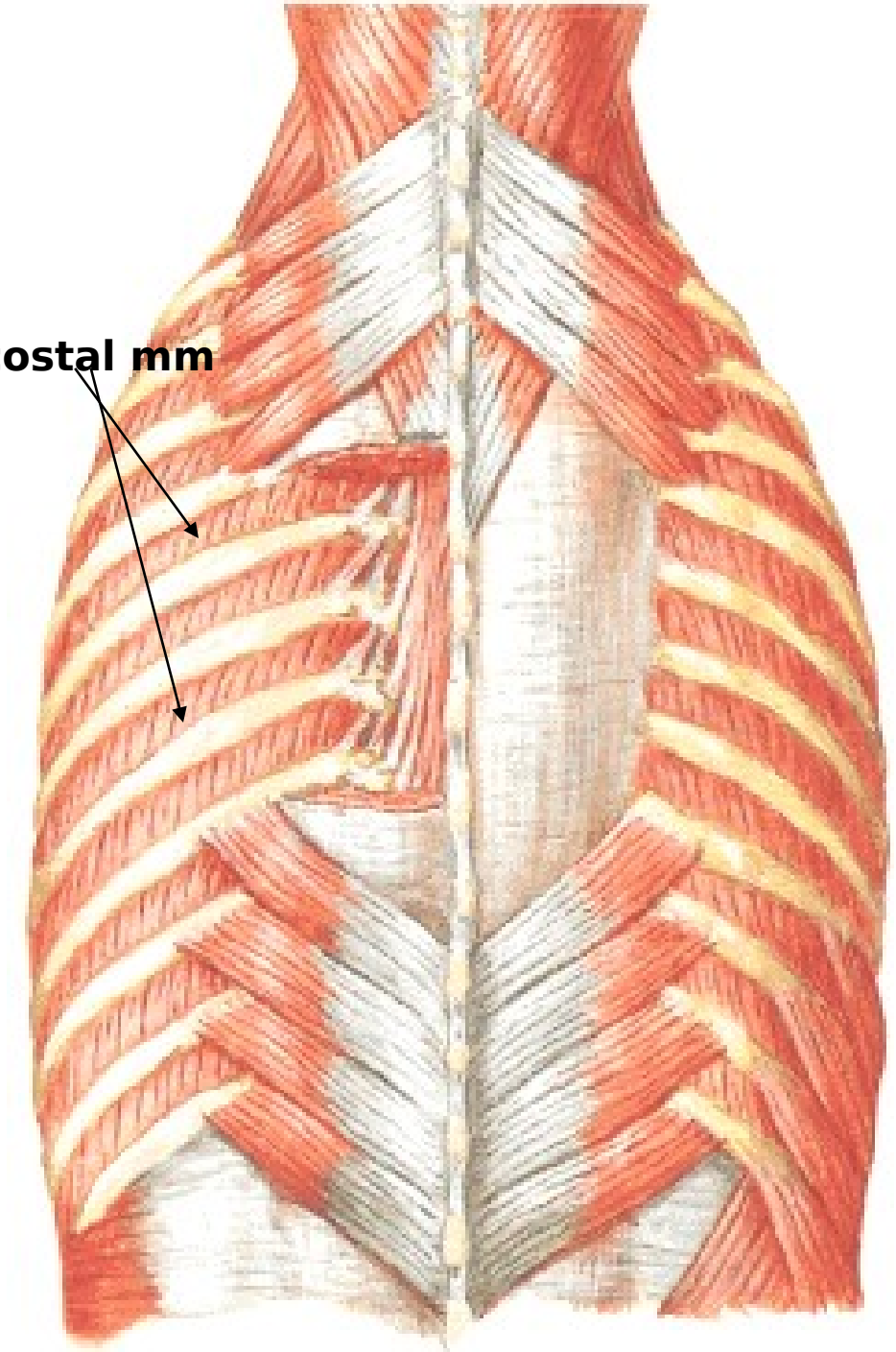

External
intercostal

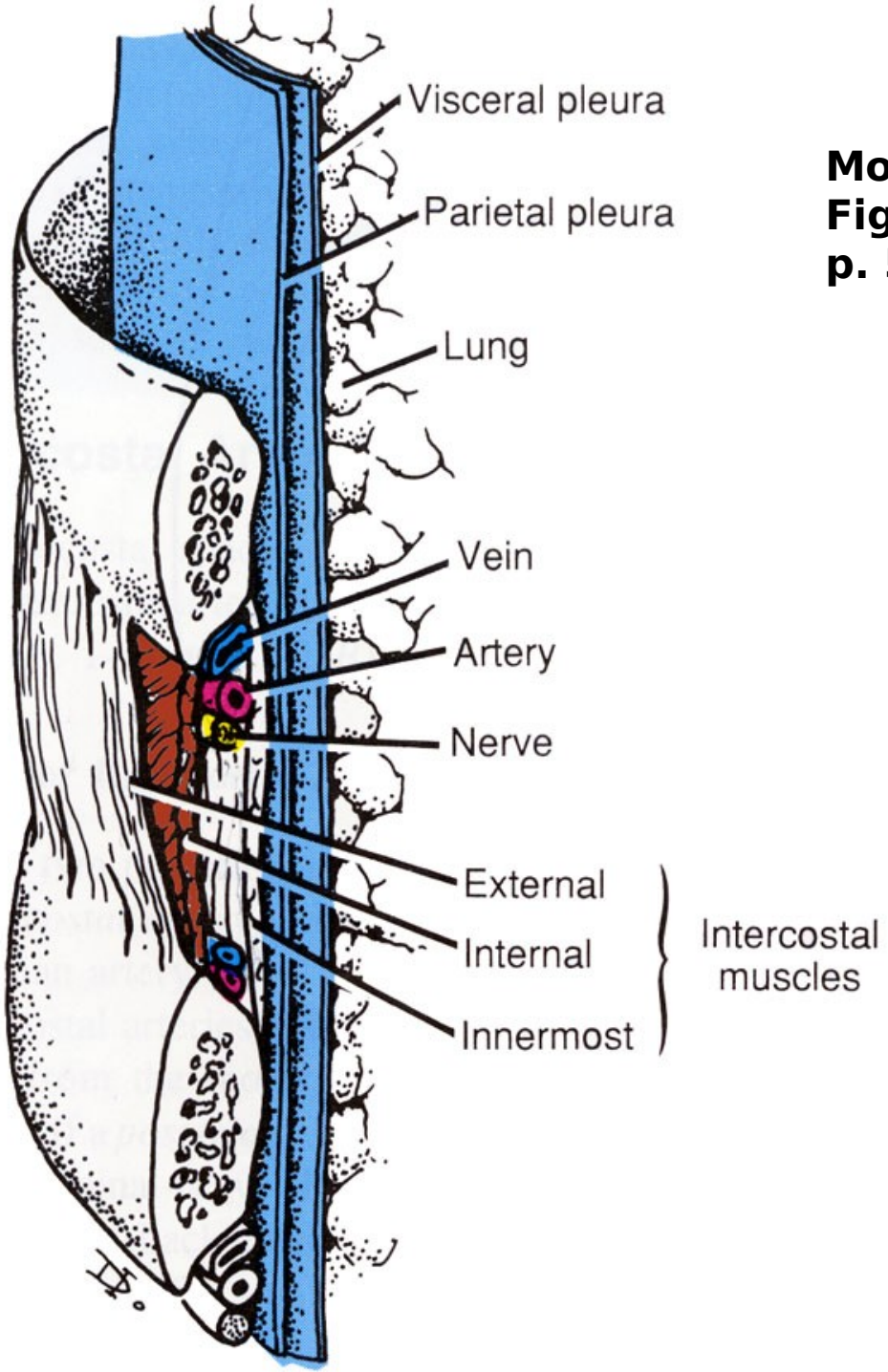

Internal
intercostal


Pectoralis minor
Intercostal mm
located
between the rib bones

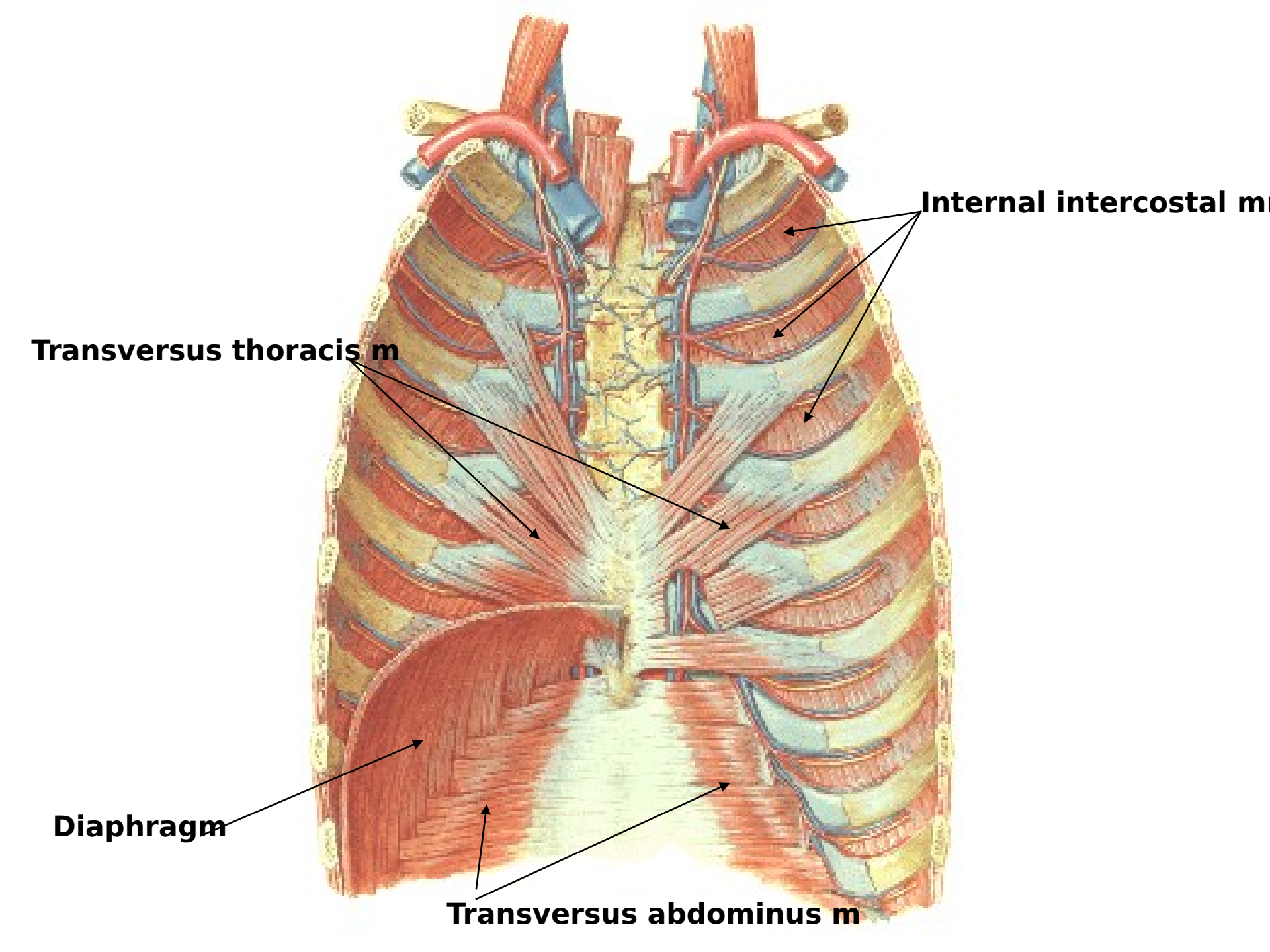

External intercostal mm
Serratus anterior

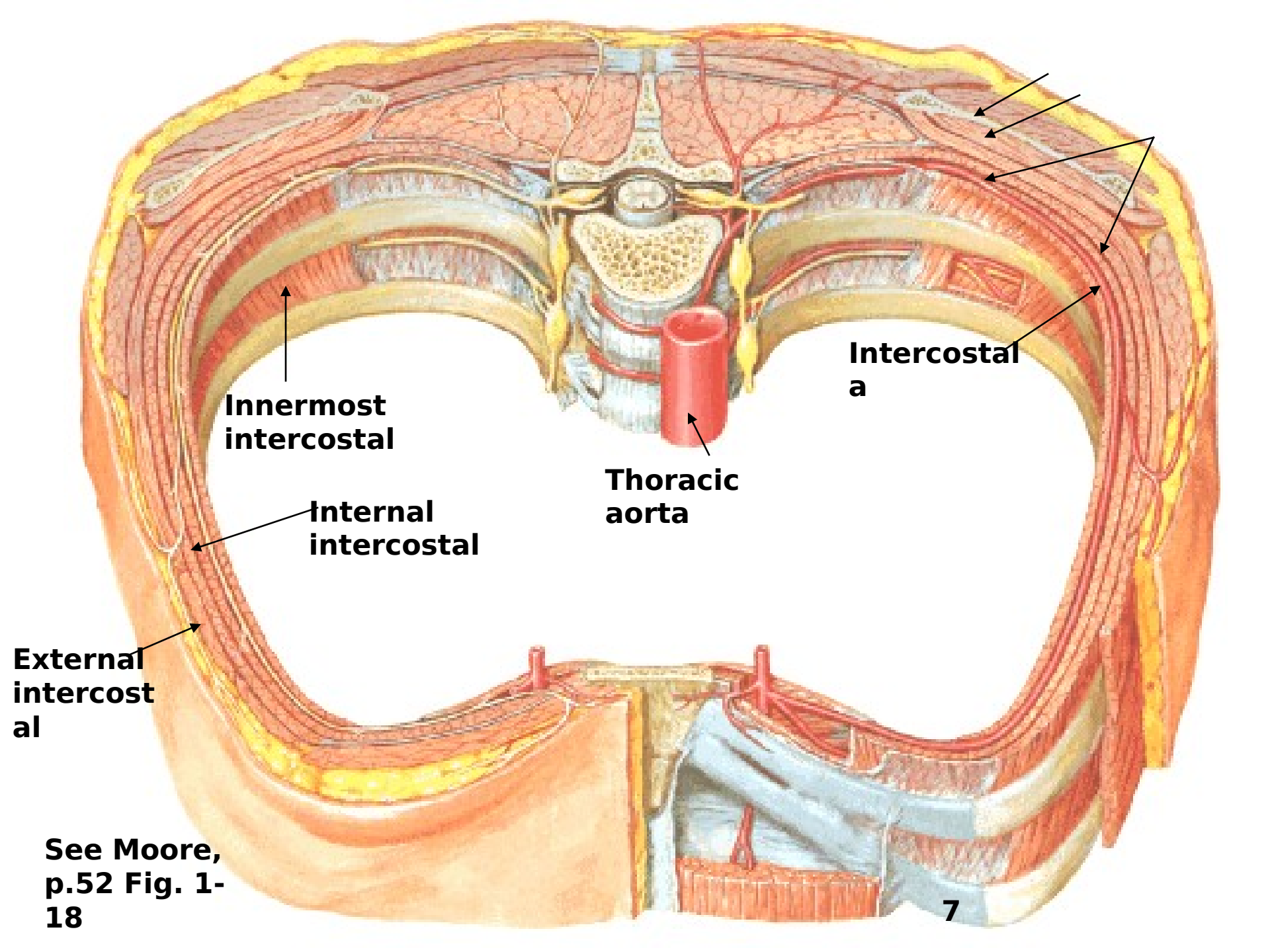
External intercostal mm



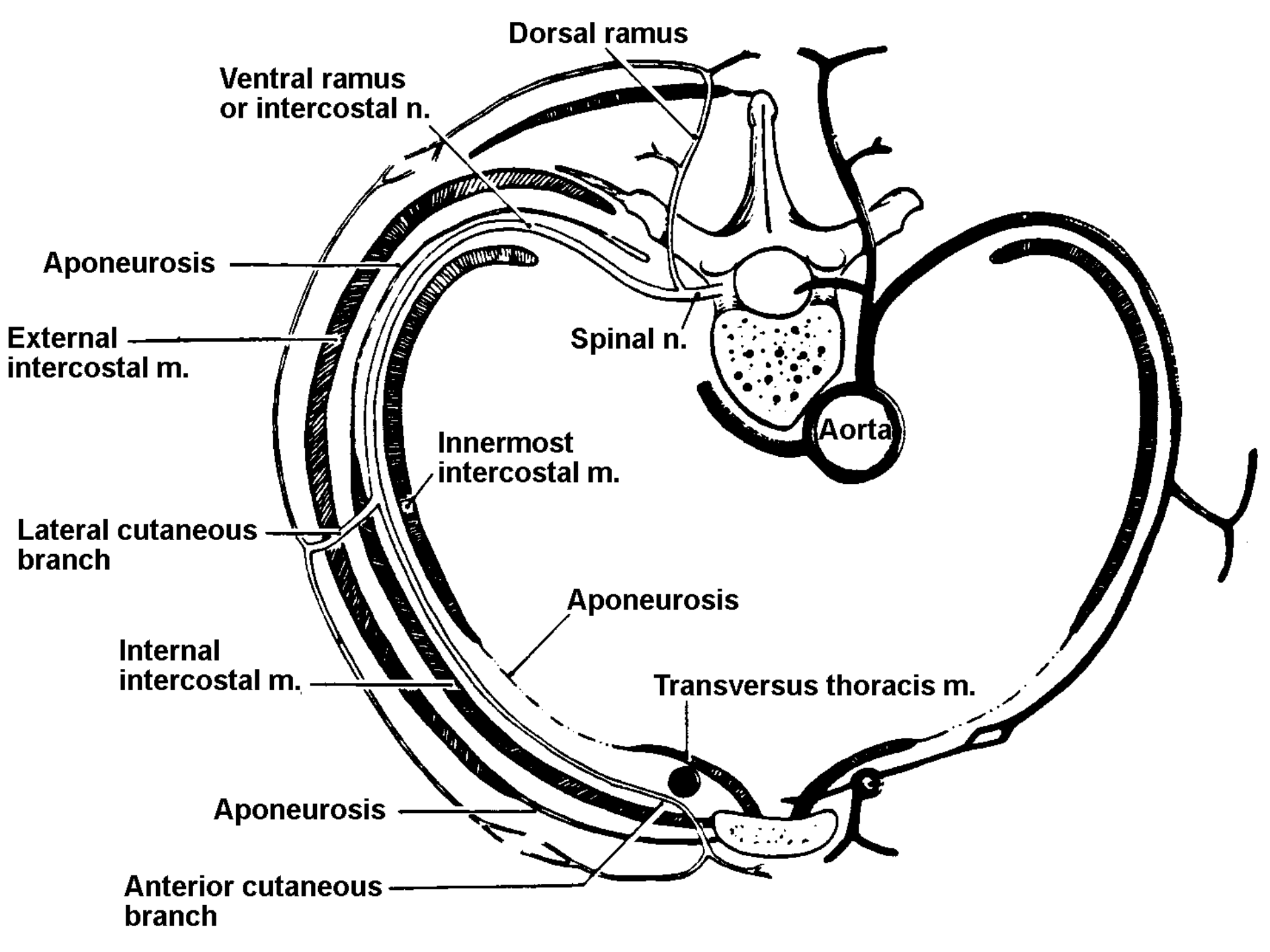


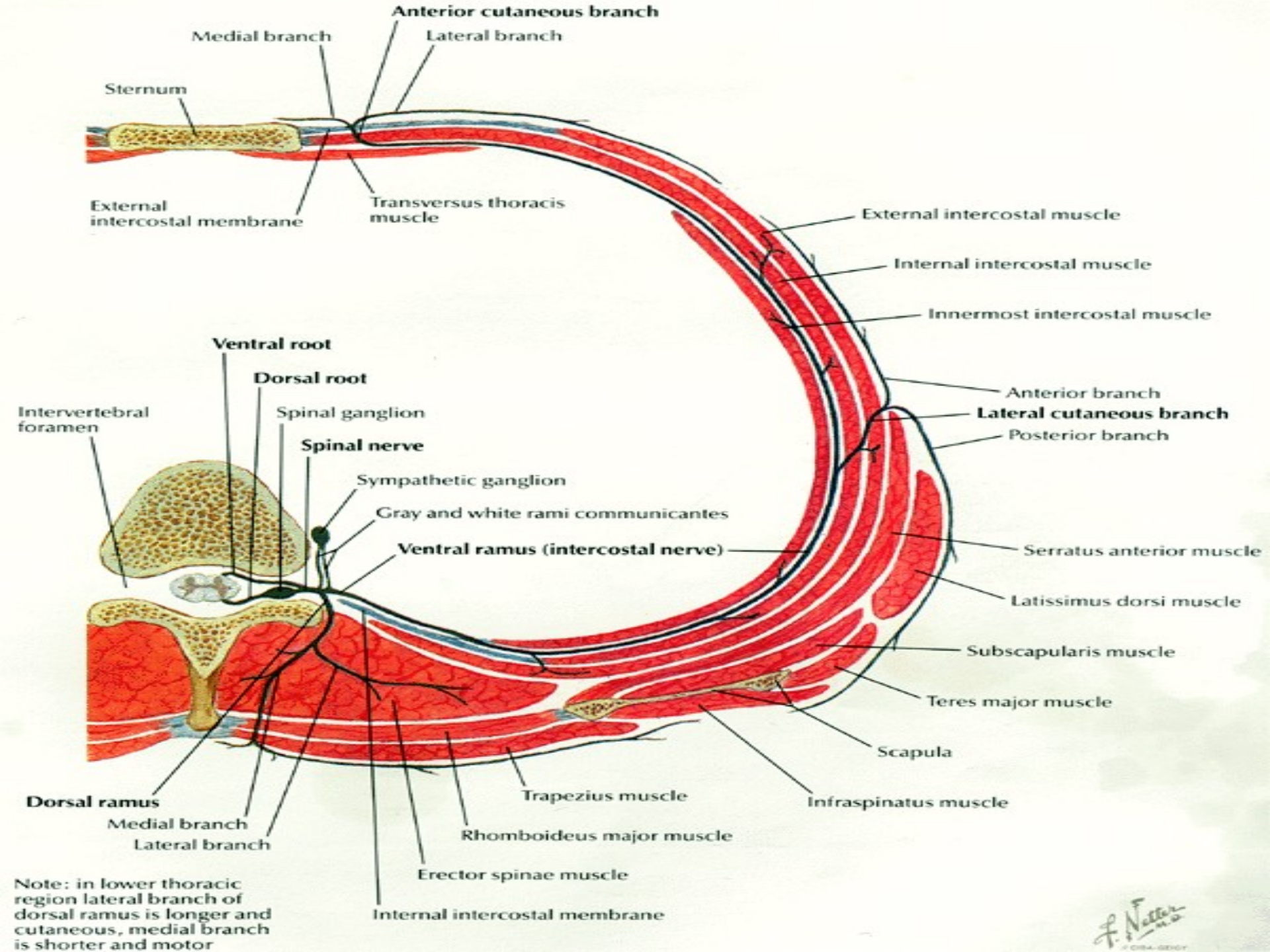
Moore
Fig. 1-23b
p. 57


Internal intercostal m
Transversus thoracis m
Diaphragm
Transversus abdominus m

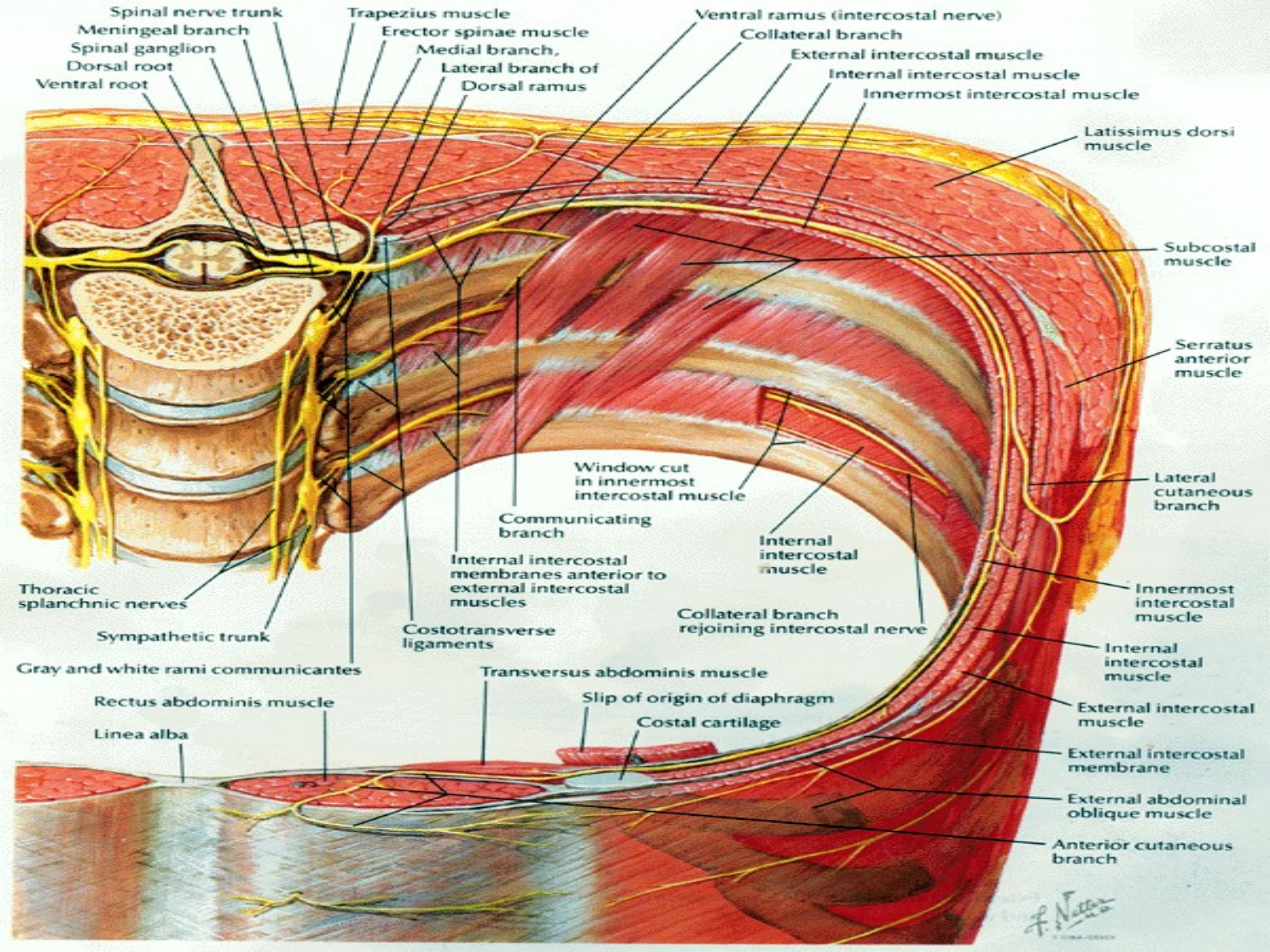


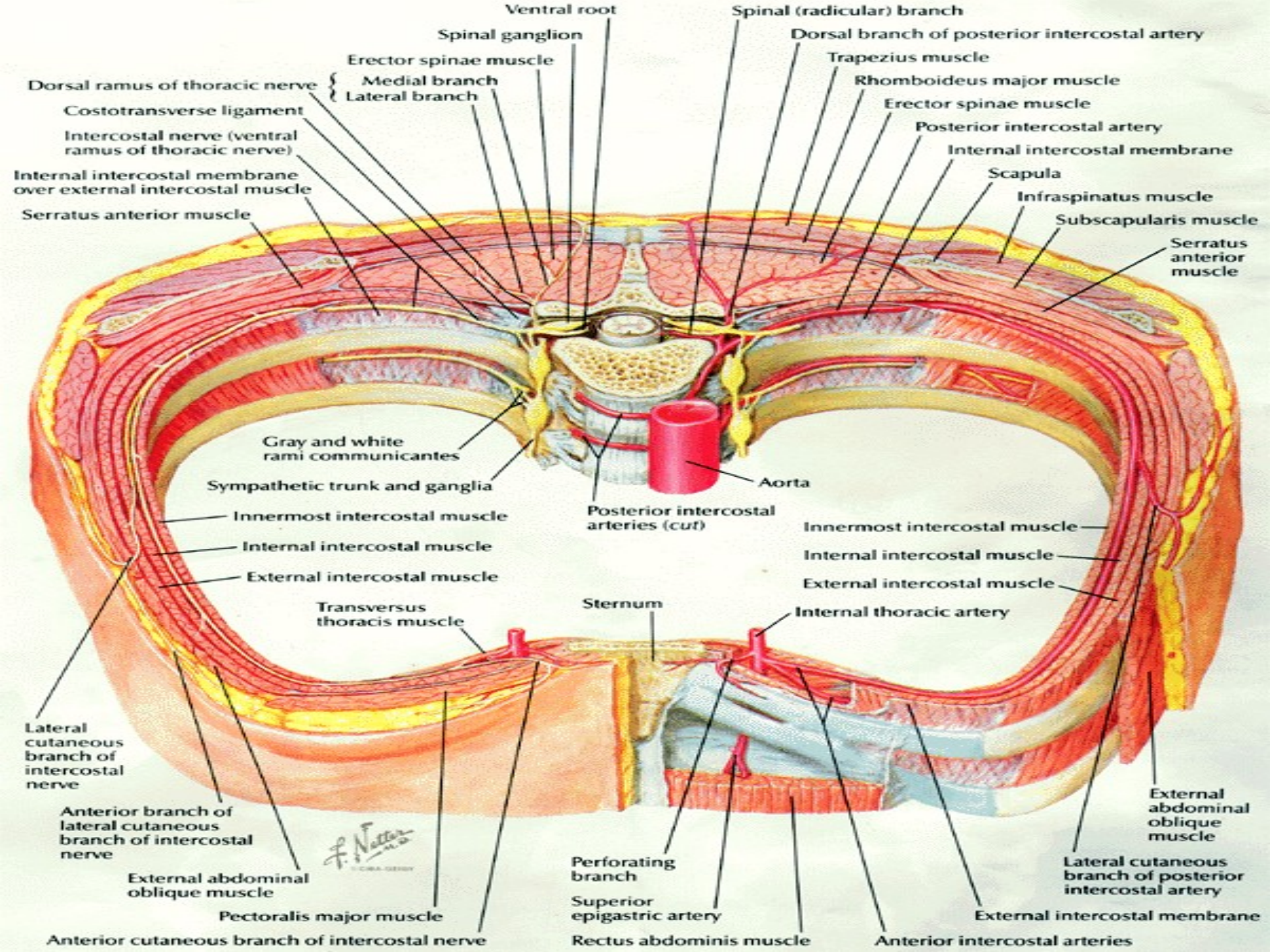
See Moore, p.52 Fig. 1-18


Dorsal ramus
Ventral ramus or intercostal n.
Aponeurosis
External intercostal m.
Spinal n.
Aorta
Innermost intercostal m.
Lateral cutaneous branch
Aponeurosis
Internal intercostal m.
Transversus thoracis m.
Aponeurosis
Anterior cutaneous branch

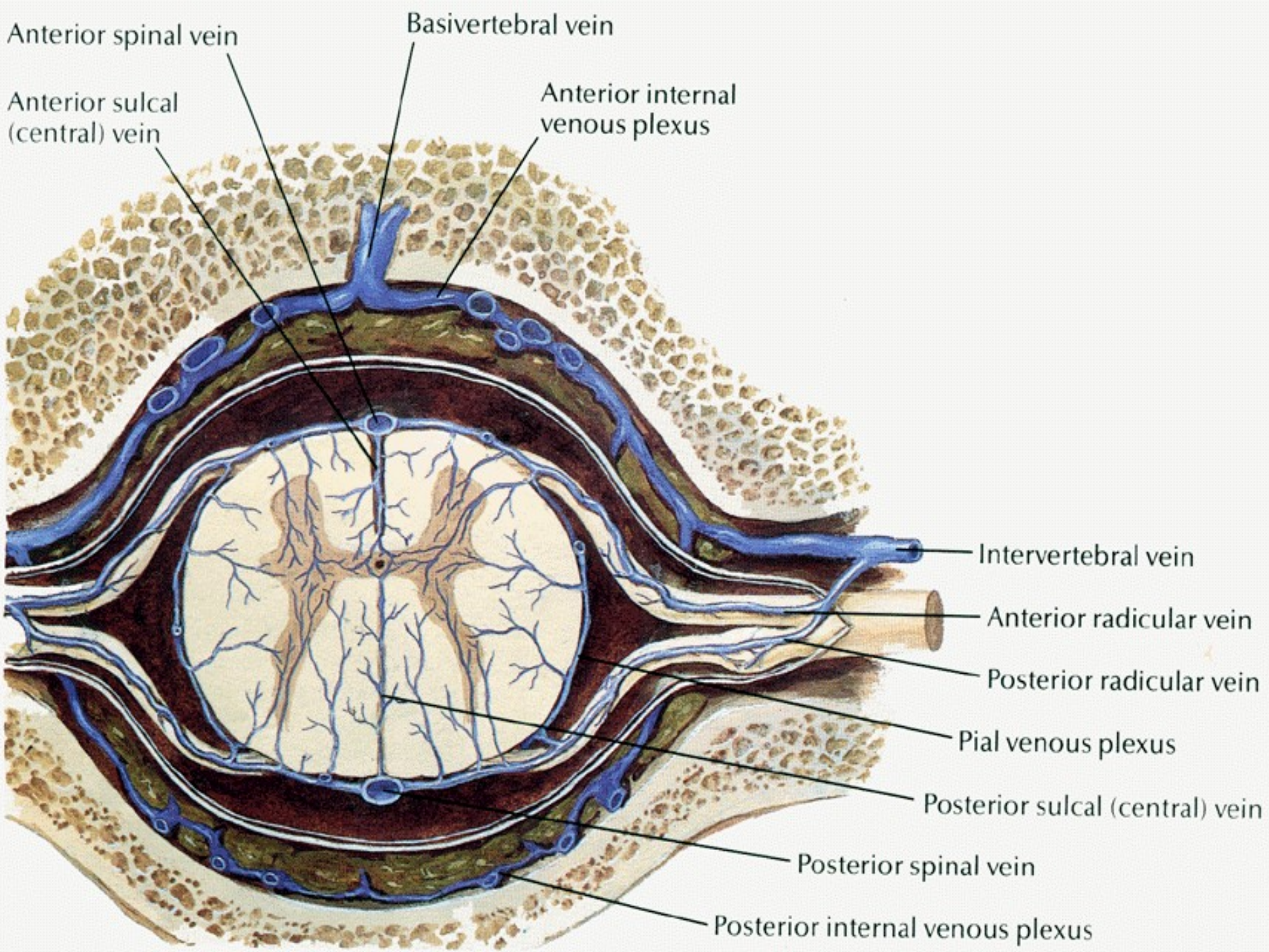


Note: in lower thoracic region lateral branch of dorsal ramus is longer and cutaneous, medial branch is shorter and motor


Spinal nerve trunk
Meningeal branch
Spinal ganglion
Dorsal root
Ventral root
Trapezius muscle
Erector spinae muscle
Medial branch,
Lateral branch of
Dorsal ramus
Ventral ramus (intercostal nerve)
Collateral branch
External intercostal muscle
Internal intercostal muscle
Innermost intercostal muscle
Latissimus dorsi muscle
Subcostal muscle
Serratus anterior muscle
Window cut in innermost intercostal muscle
Communicating branch
Internal intercostal muscle
Lateral cutaneous branch
Internal intercostal membranes anterior to external intercostal muscles
Thoracic splanchnic nerves
Sympathetic trunk
Costotransverse ligaments
Collateral branch rejoining intercostal nerve
Innermost intercostal muscle
Internal intercostal muscle
Gray and white rami communicantes
Transversus abdominis muscle
Slip of origin of diaphragm
Rectus abdominis muscle
Costal cartilage
External intercostal muscle
Linea alba
External intercostal membrane
External abdominal oblique muscle
Anterior cutaneous branch

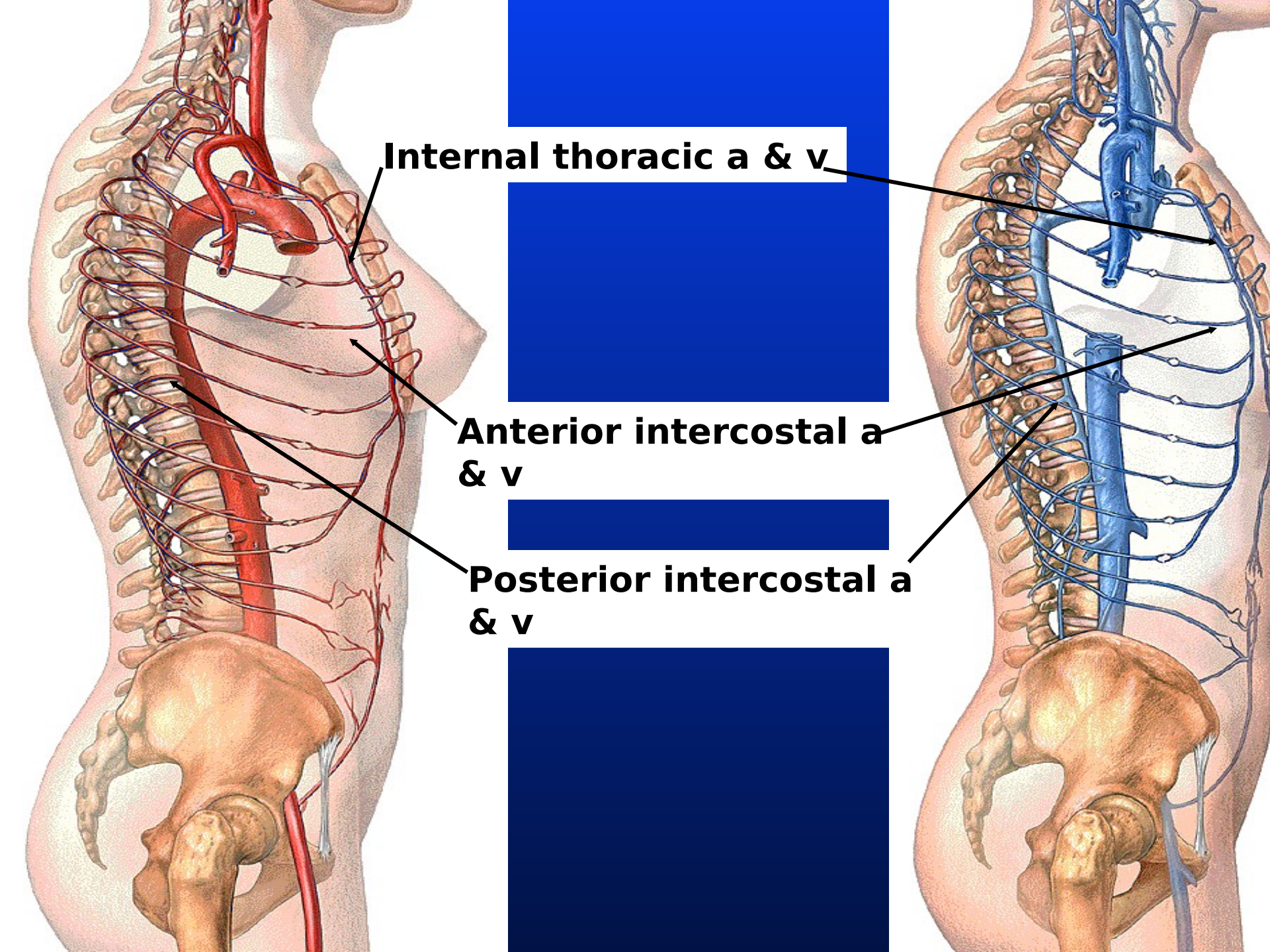

Ventral root
Spinal ganglion
Erector spinae muscle
Medial branch
Lateral branch
Dorsal ramus of thoracic nerve
Costotransverse ligament
Intercostal nerve (ventral ramus of thoracic nerve)
Internal intercostal membrane over external intercostal muscle
Serratus anterior muscle
Spinal (radicular) branch
Dorsal branch of posterior intercostal artery
Trapezius muscle
Rhomboideus major muscle
Erector spinae muscle
Posterior intercostal artery
Internal intercostal membrane
Scapula
Infraspinatus muscle
Subscapularis muscle
Serratus anterior muscle
Gray and white rami communicantes
Sympathetic trunk and ganglia
Aorta
Posterior intercostal arteries (cut)
Innermost intercostal muscle
Internal intercostal muscle
External intercostal muscle
Innermost intercostal muscle
Internal intercostal muscle
External intercostal muscle
Transversus thoracis muscle
Sternum
Internal thoracic artery
Lateral cutaneous branch of intercostal nerve
Anterior branch of lateral cutaneous branch of intercostal nerve
External abdominal oblique muscle
Pectoralis major muscle
Anterior cutaneous branch of intercostal nerve
Perforating branch
Superior epigastric artery
Rectus abdominis muscle
Anterior intercostal arteries
External intercostal membrane
Lateral cutaneous branch of posterior intercostal artery
External abdominal oblique muscle

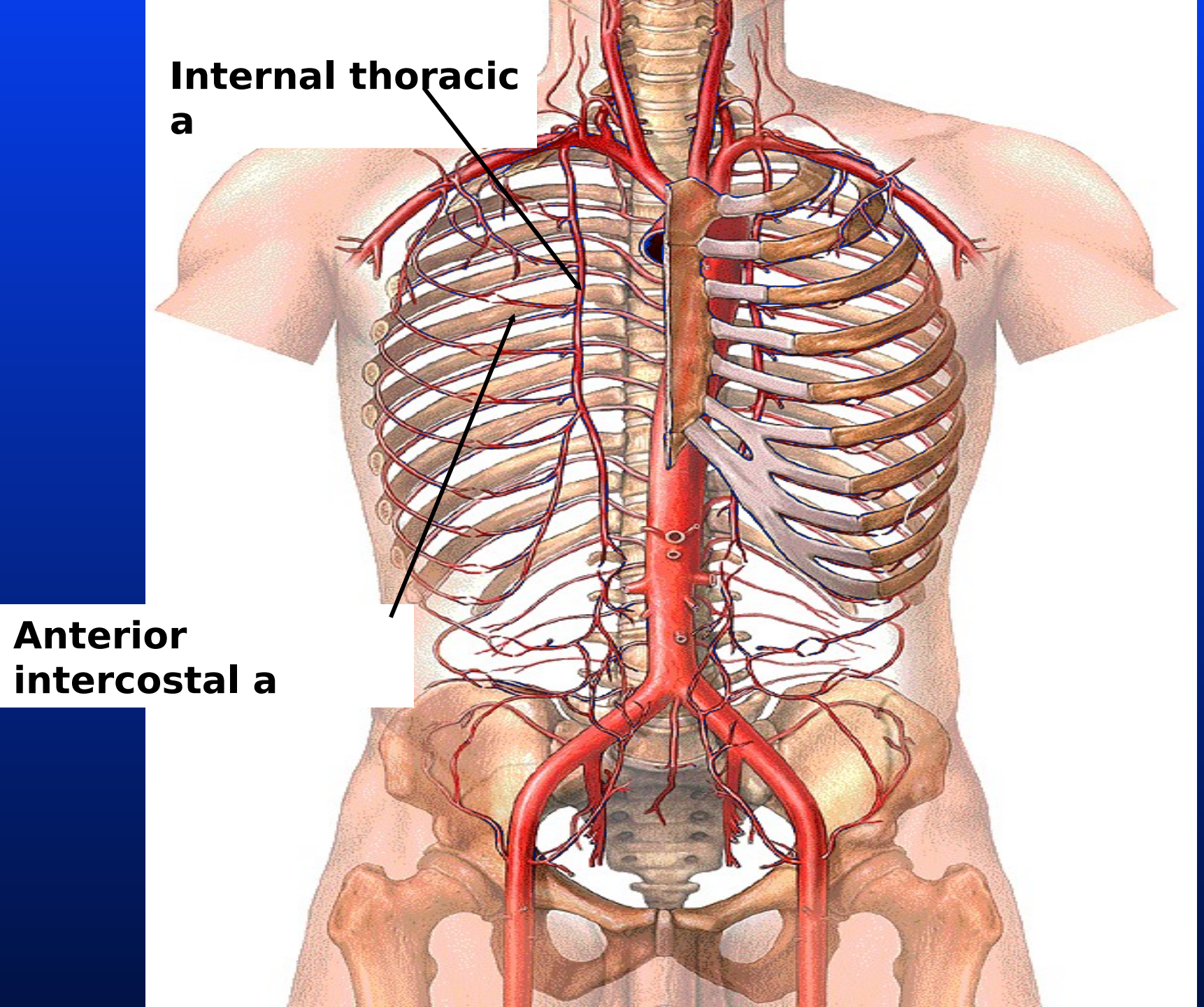
BLOOD VESSELS

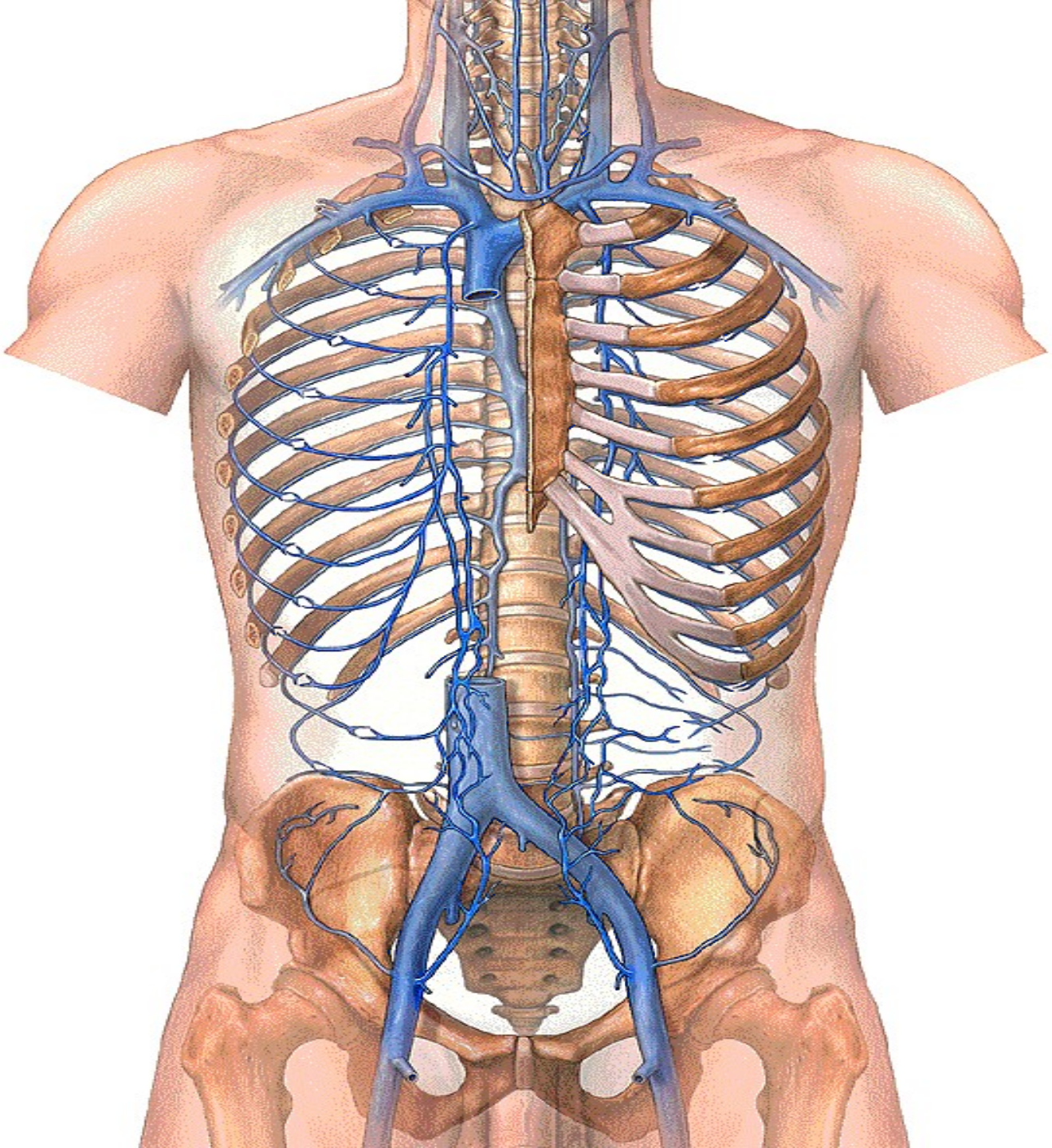

Anterior spinal vein
Basivertebral vein
Anterior sulcal (central) vein
Anterior internal venous plexus
Intervertebral vein
Anterior radicular vein
Posterior radicular vein
Pial venous plexus
Posterior sulcal (central) vein
Posterior spinal vein
Posterior internal venous plexus

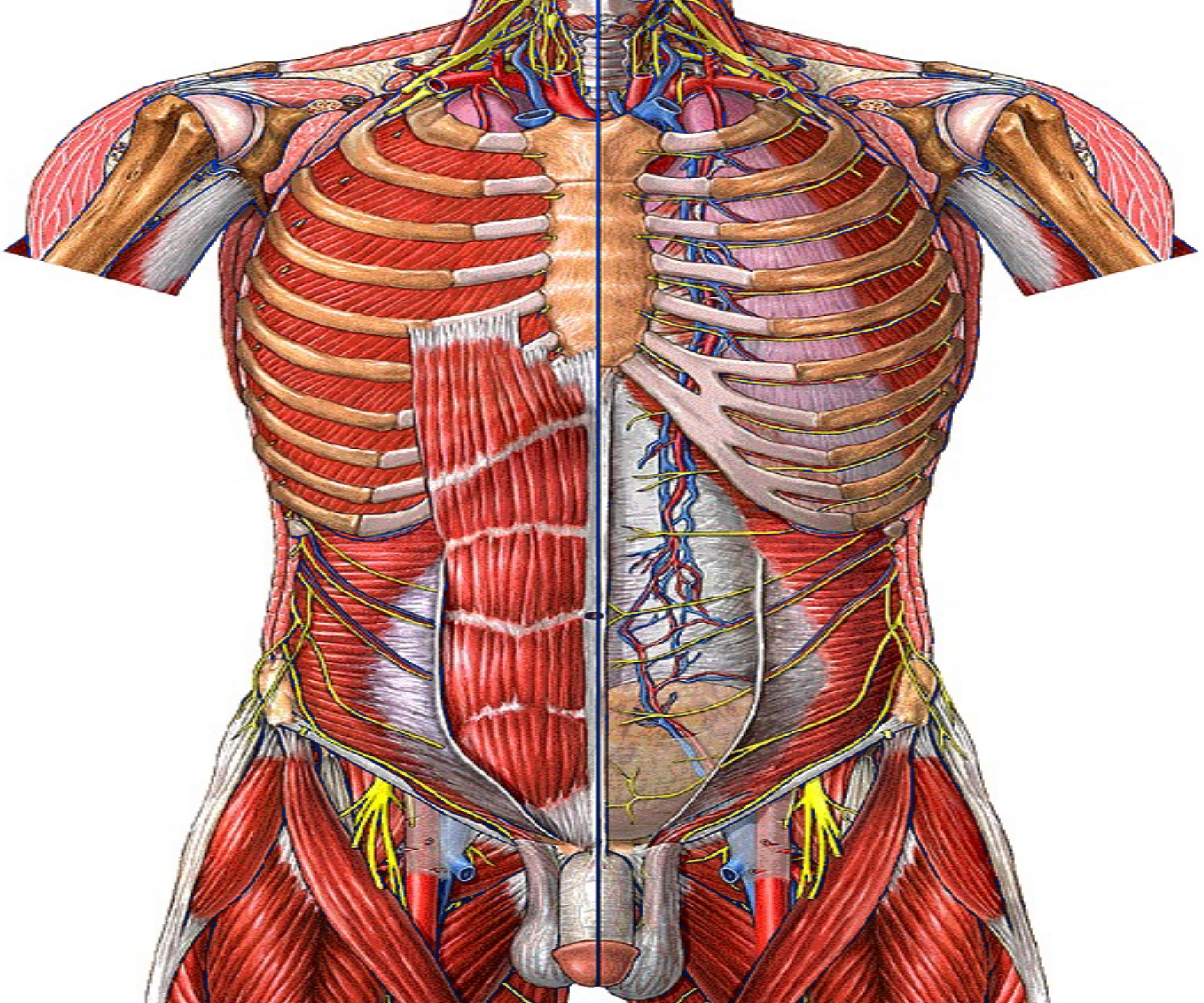
THORACIC VESSELS

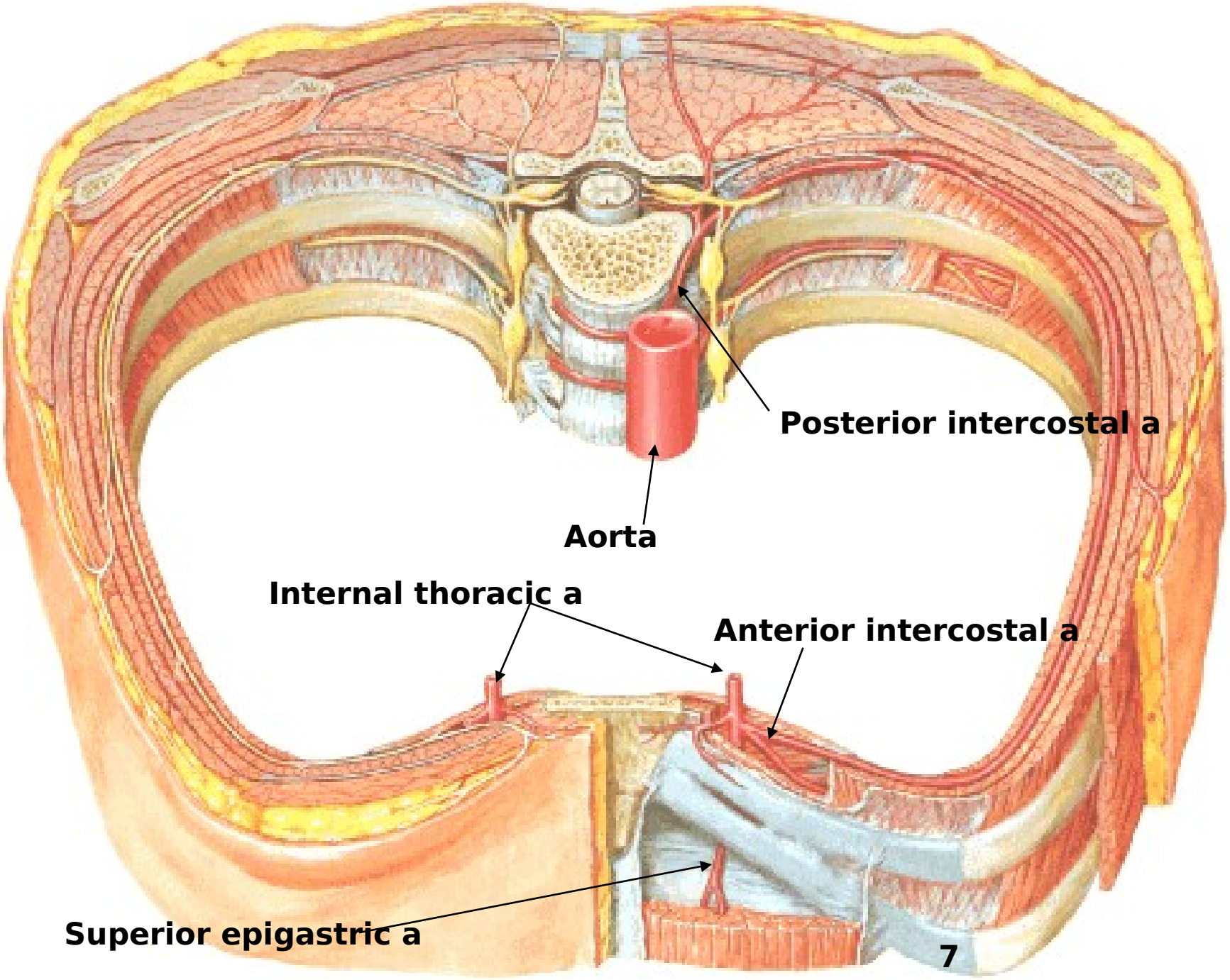
- Aorta
- Intercostal aa, vv, (& nn)
  - Posterior intercostal aa
- Internal thoracic a
  - Anterior intercostal aa
  - Terminates as:
    - Superior epigastric a
    - Musculophrenic a


Internal thoracic a & v
Anterior intercostal a & v
Posterior intercostal a & v


Internal thoracic a
Anterior intercostal a

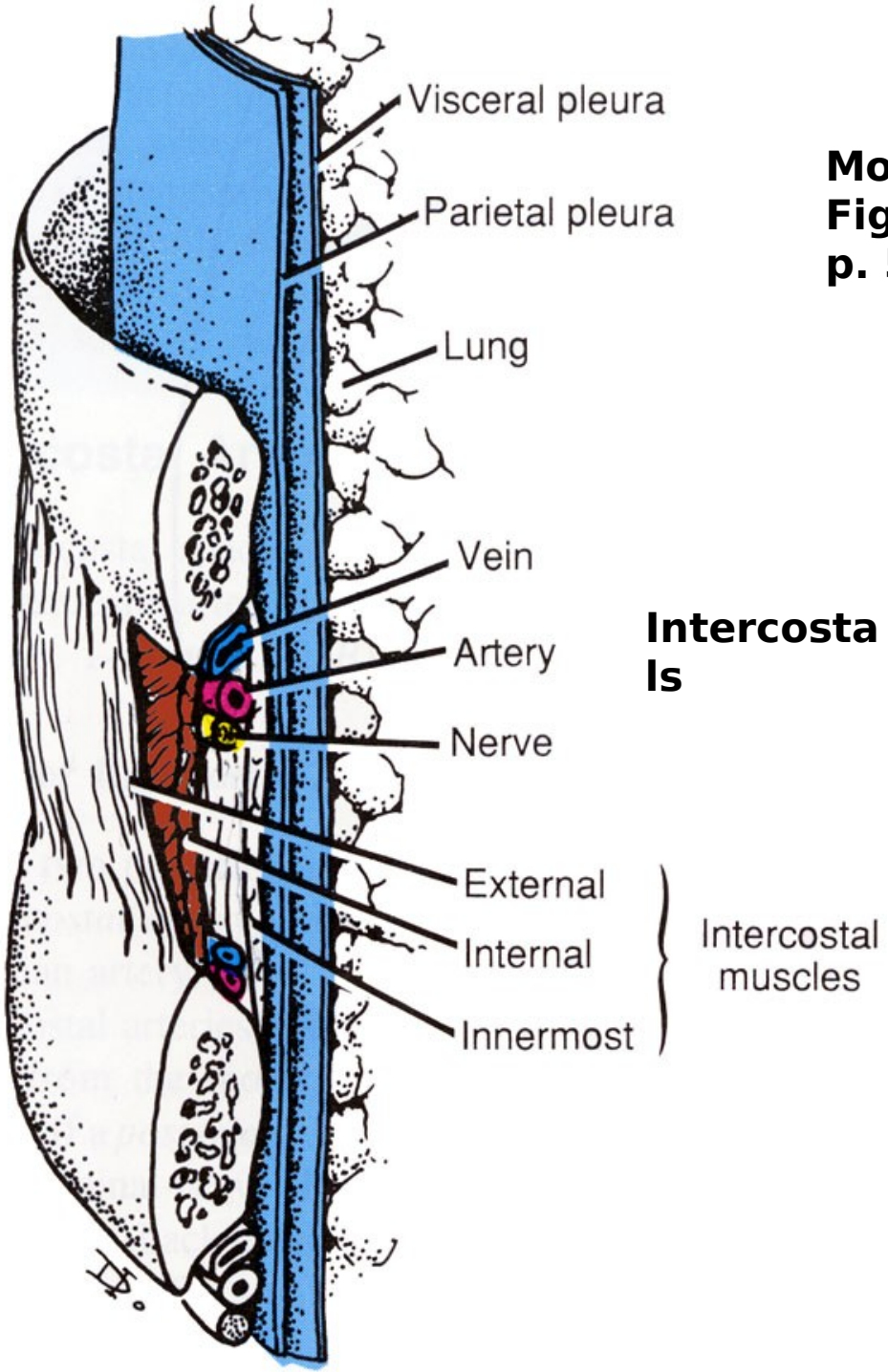





Posterior intercostal a
Aorta
Internal thoracic a
Anterior intercostal a
Superior epigastric a

INTERCOSTAL N.A.V.

- Lie between internal and innermost intercostal mm
  - V.A.N. (superior to inferior)
  - Contained in costal groove

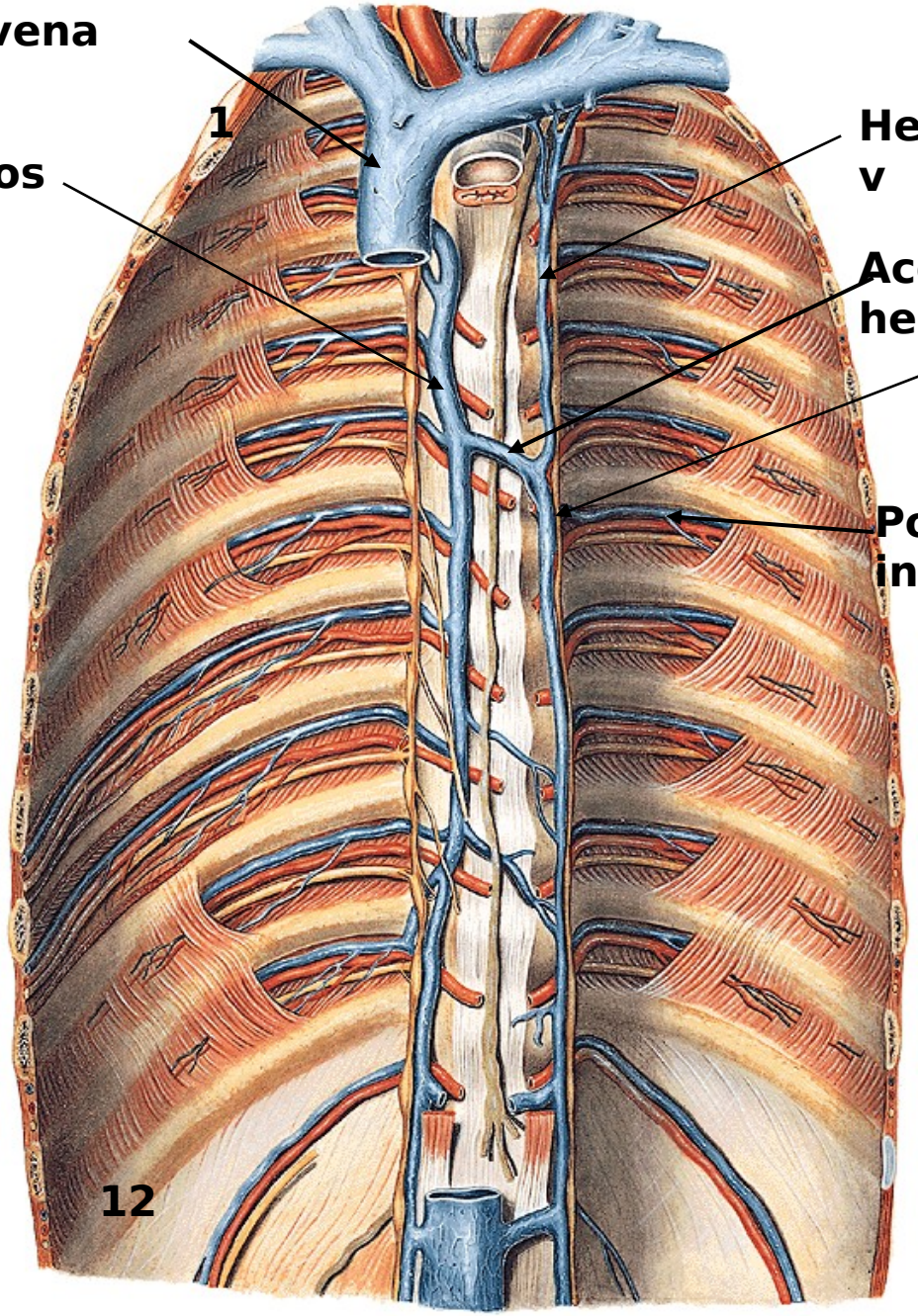


Moore
Fig. 1-23b
p. 57

Intercostals

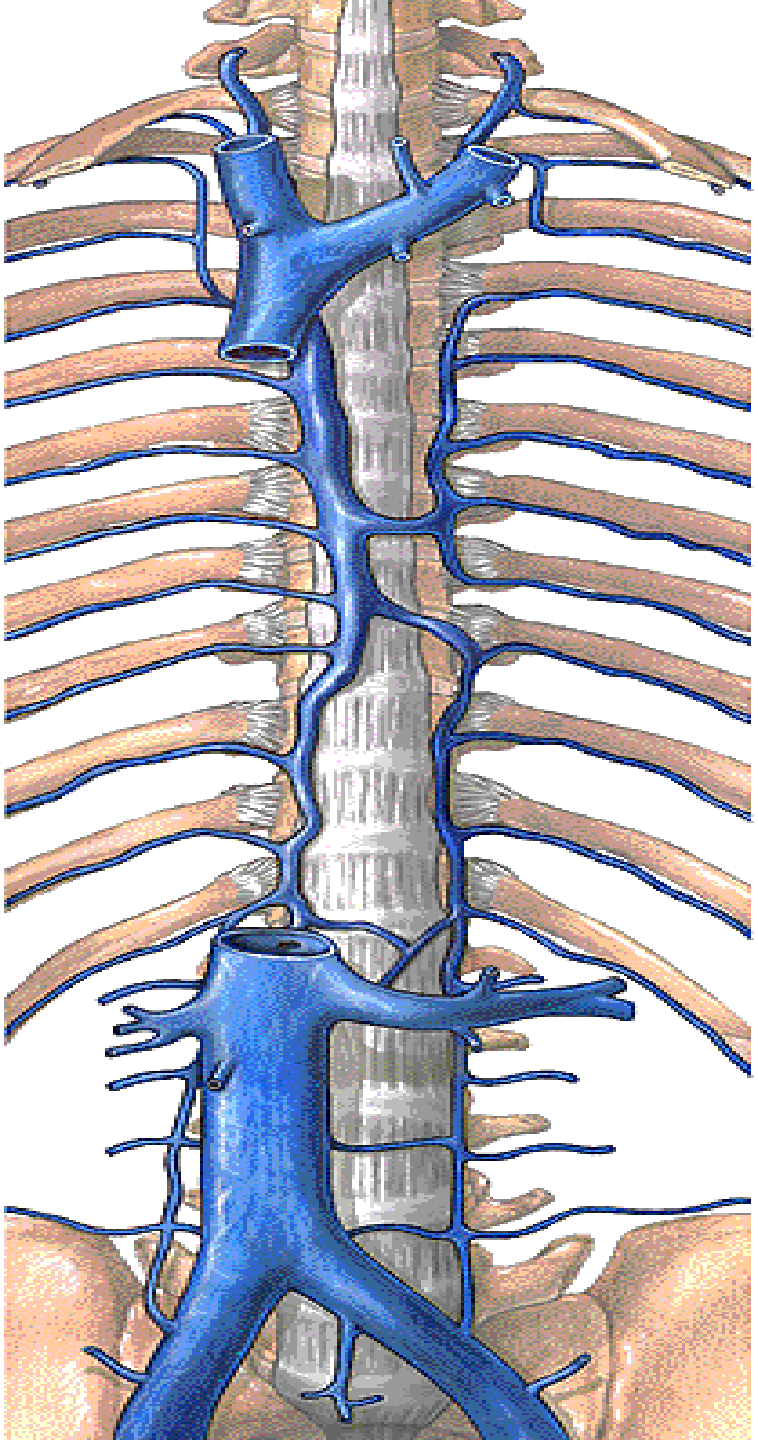
VENOUS DRAINAGE

- Azygous v
- Hemiazygous v
- Accessory hemiazygous v
- Internal thoracic vv
  - To subclavian vv
- Intercostal vv
  - To azygous system/int thoracic vv



Note:
V
A
N

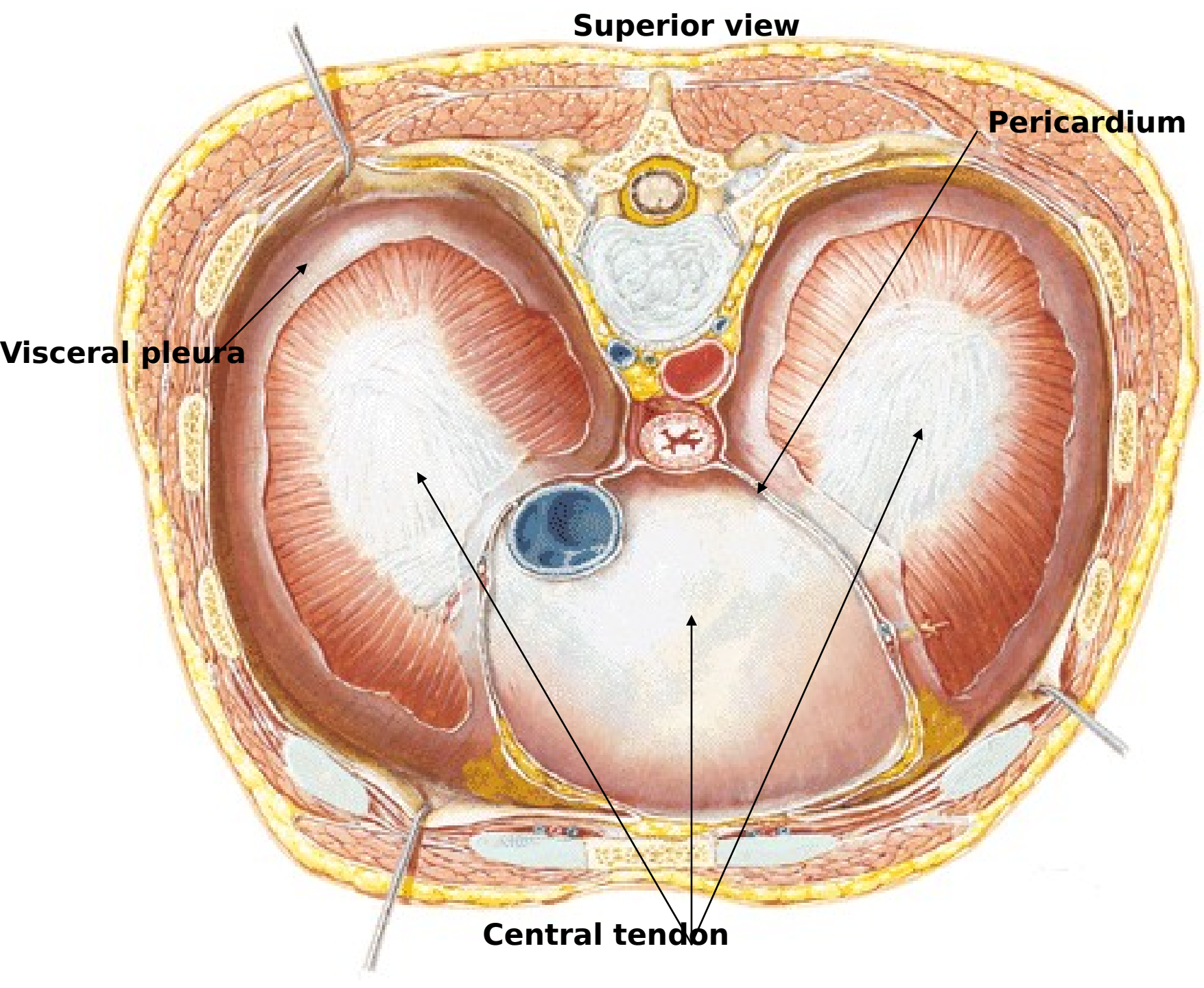
See Moore, p. 119, Fig. 1-76

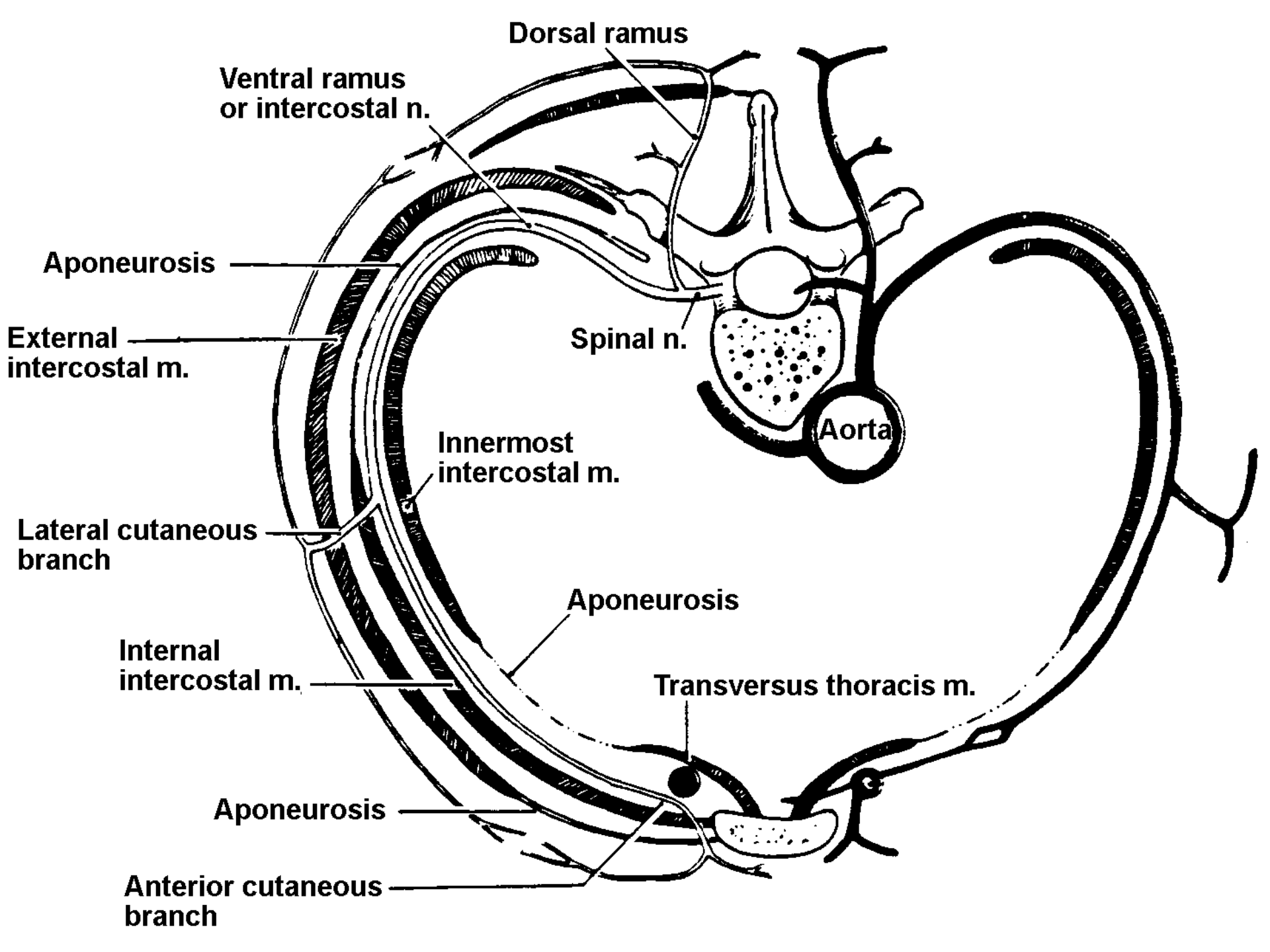


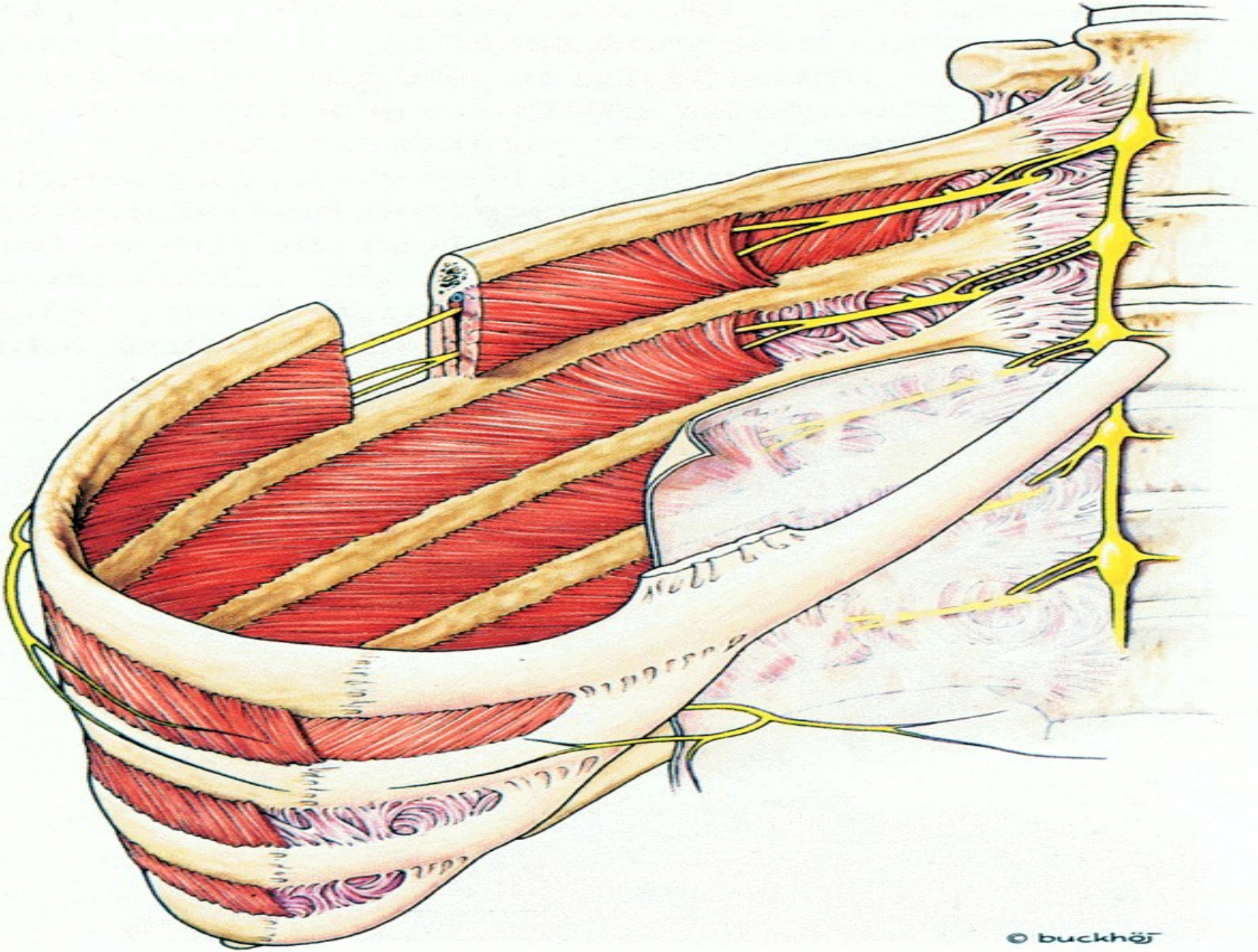
See T&G, p.654 &655;
Fig. 21.26

FLOOR

- Diaphragm separates the thoracic and abdominal cavities
  - Dome-shaped muscle
  - Top of “dome” is tendinous


Superior view
Pericardium
Visceral pleura
Central tendon

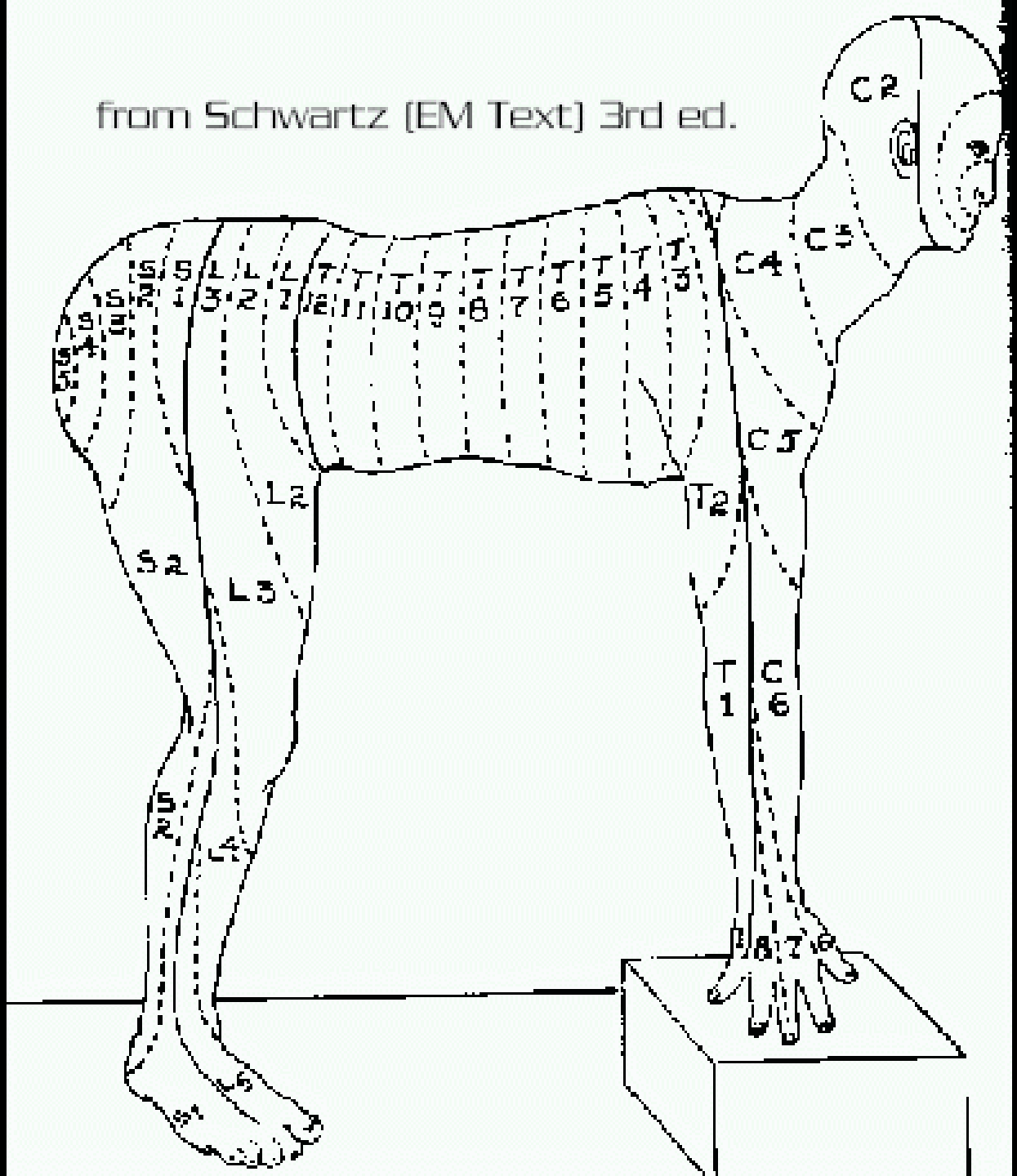

Dorsal ramus
Ventral ramus or intercostal n.
Aponeurosis
External intercostal m.
Spinal n.
Aorta
Innermost intercostal m.
Lateral cutaneous branch
Aponeurosis
Internal intercostal m.
Transversus thoracis m.
Aponeurosis
Anterior cutaneous branch

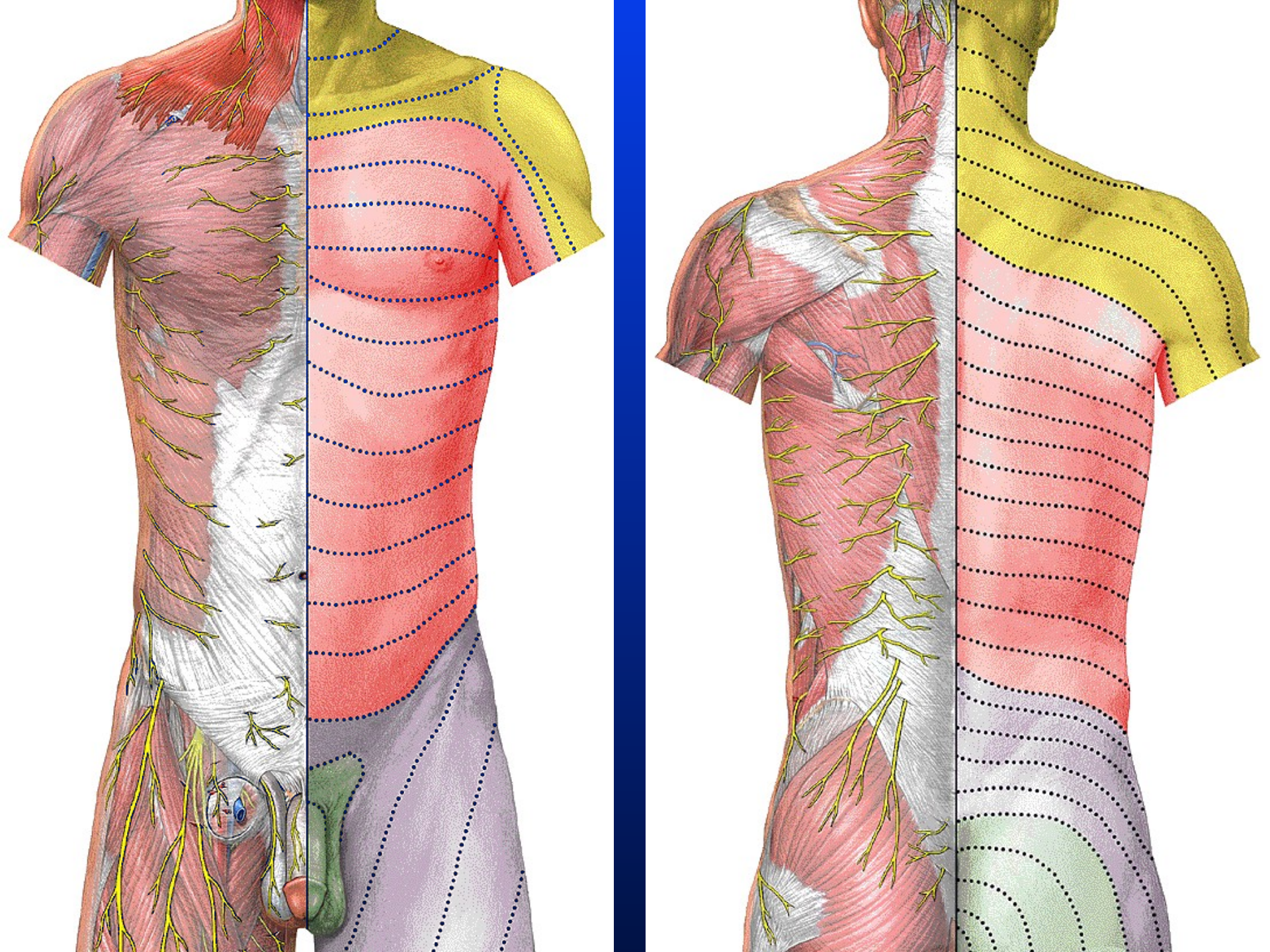

© buckhöj

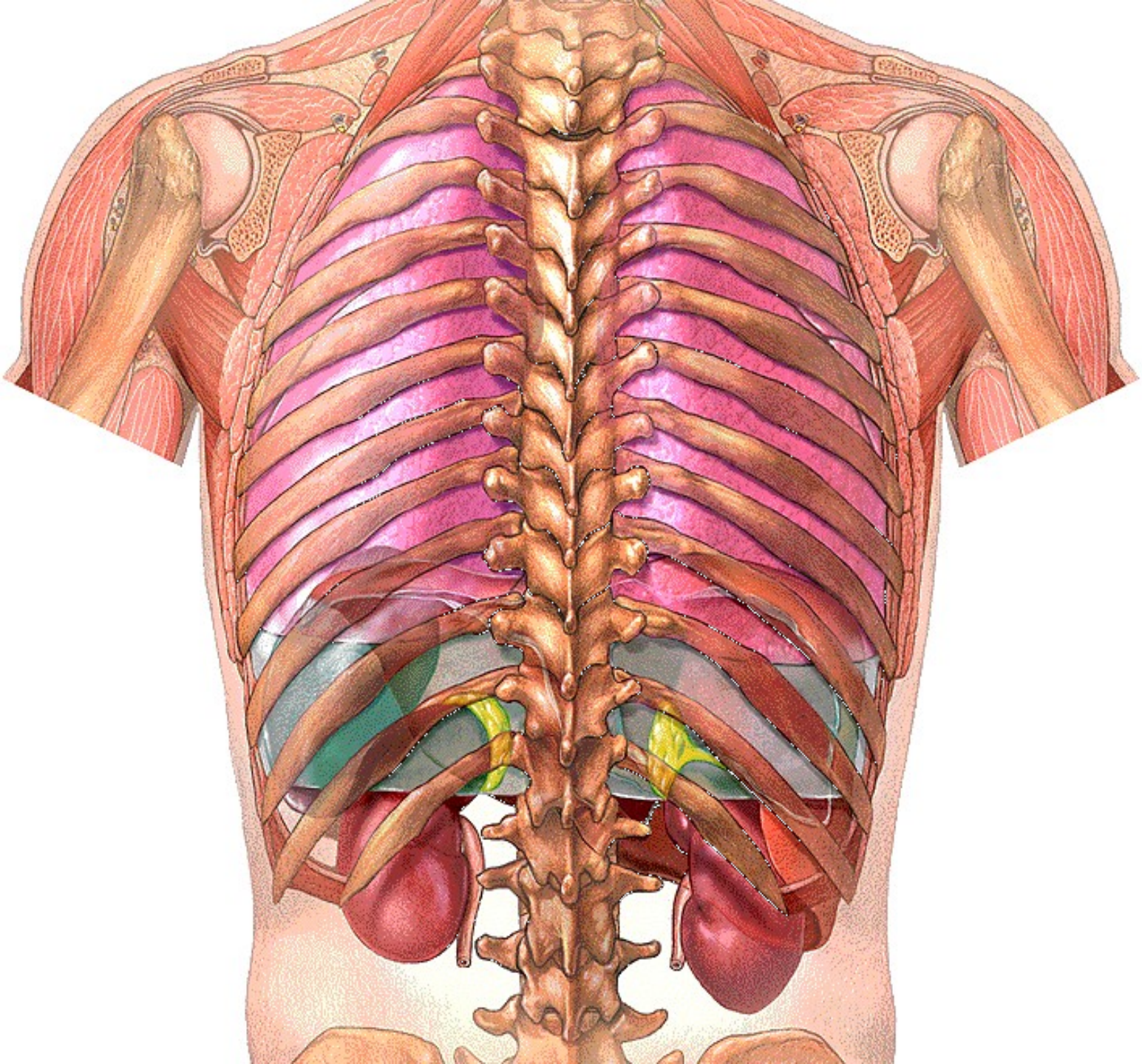
PELVIS

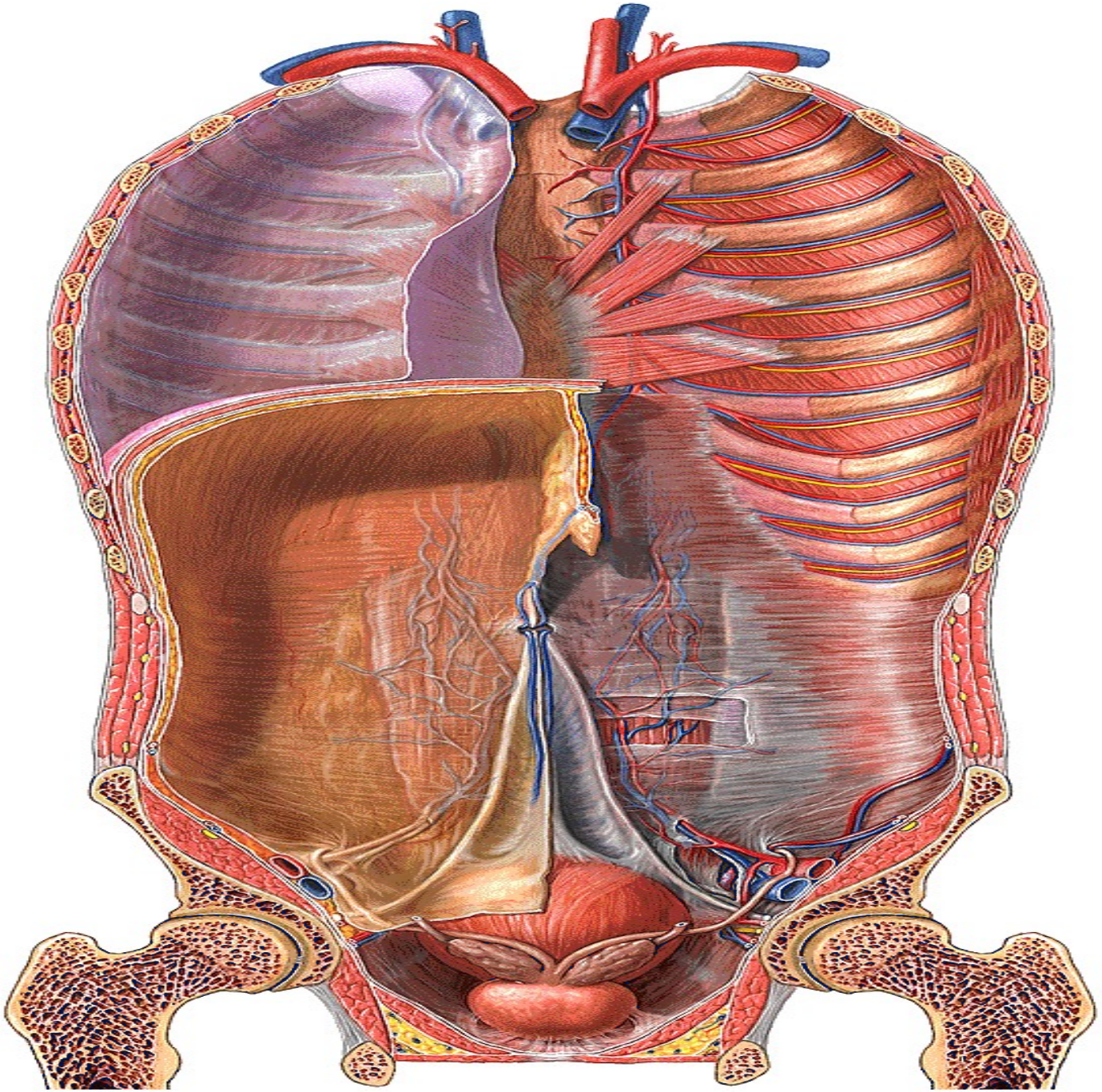
- Boundaries
  - Pelvic inlet
  - Pelvic diaphragm
  - Walls
    - Hip bones (ant & lat)
    - Sacrum (post)
    - Obturator membrane
      - Muscles

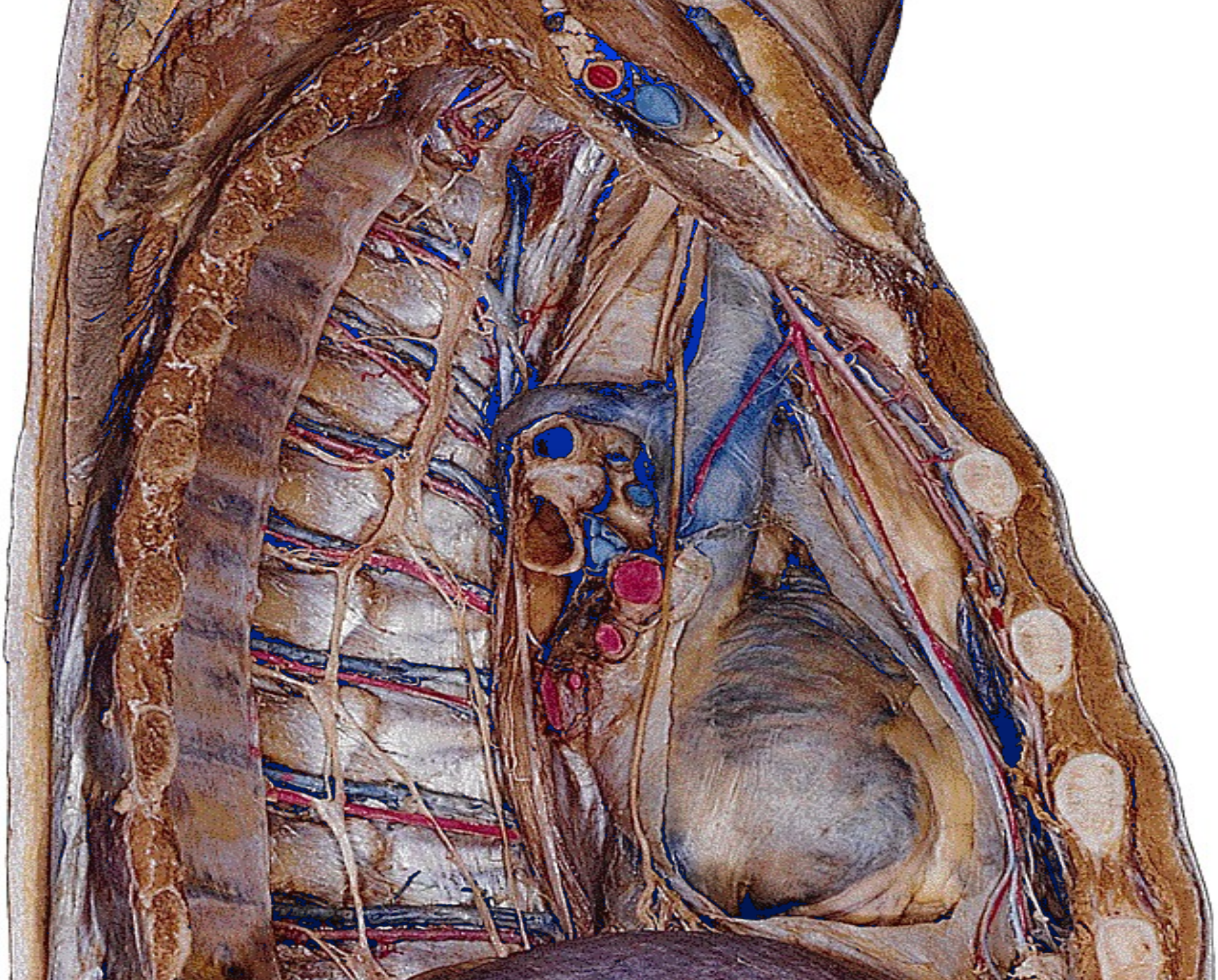
DERMATOMES

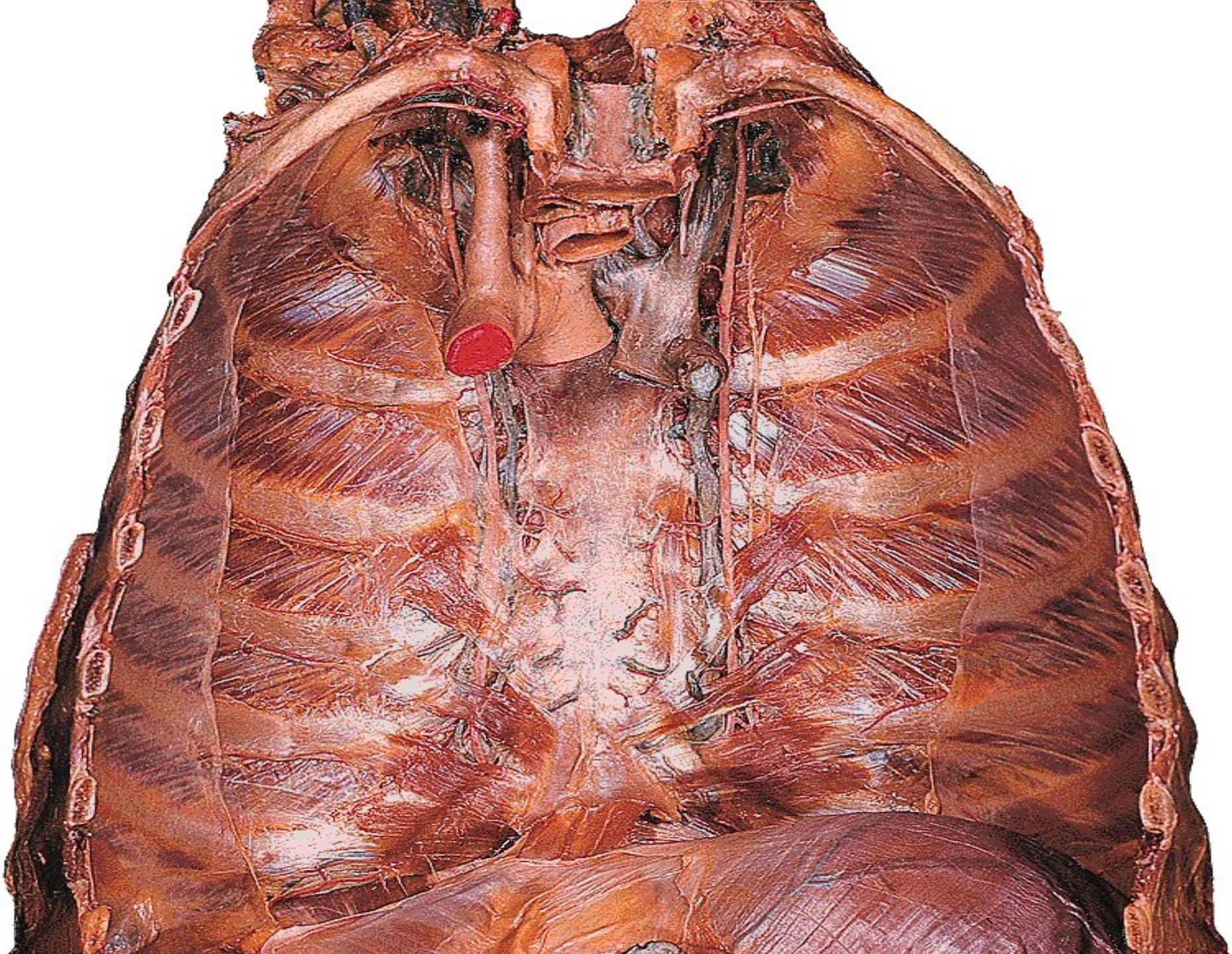

from Schwartz (EM Text) 3rd ed.
C2
C5
C4
C5
C6
T1
T2
L2
L3
S2







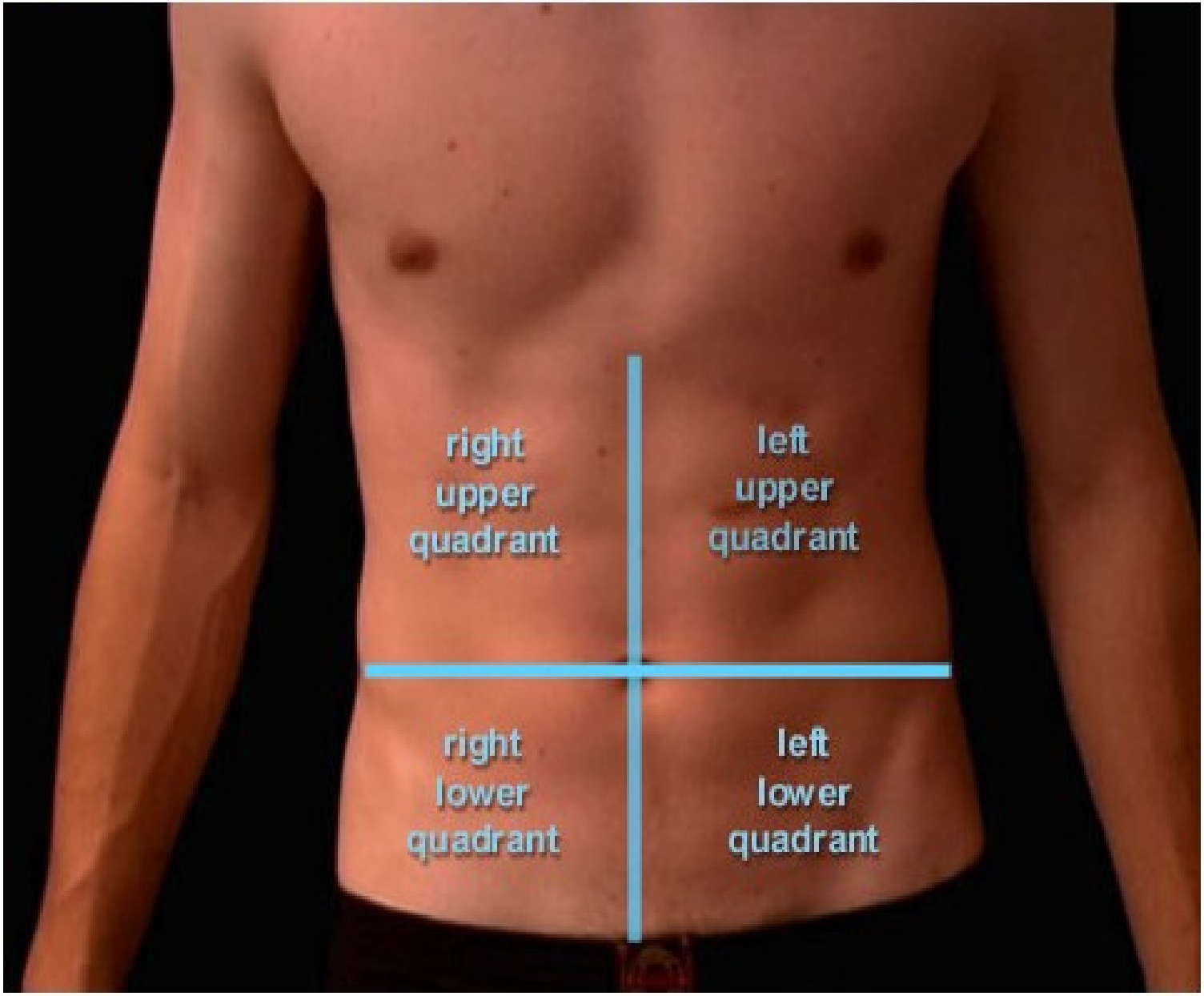




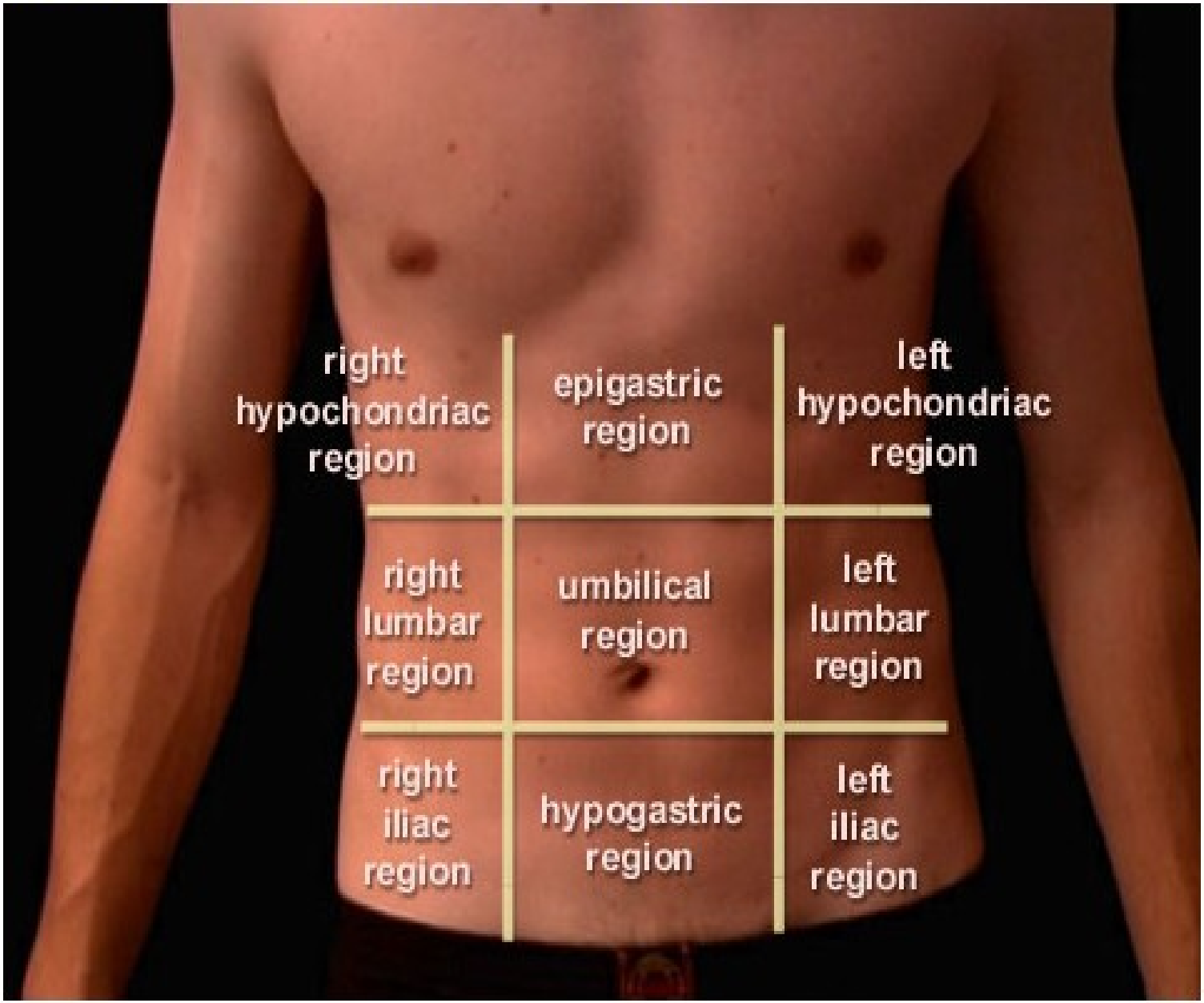
DERMATOMES

The Abdominal Cavity

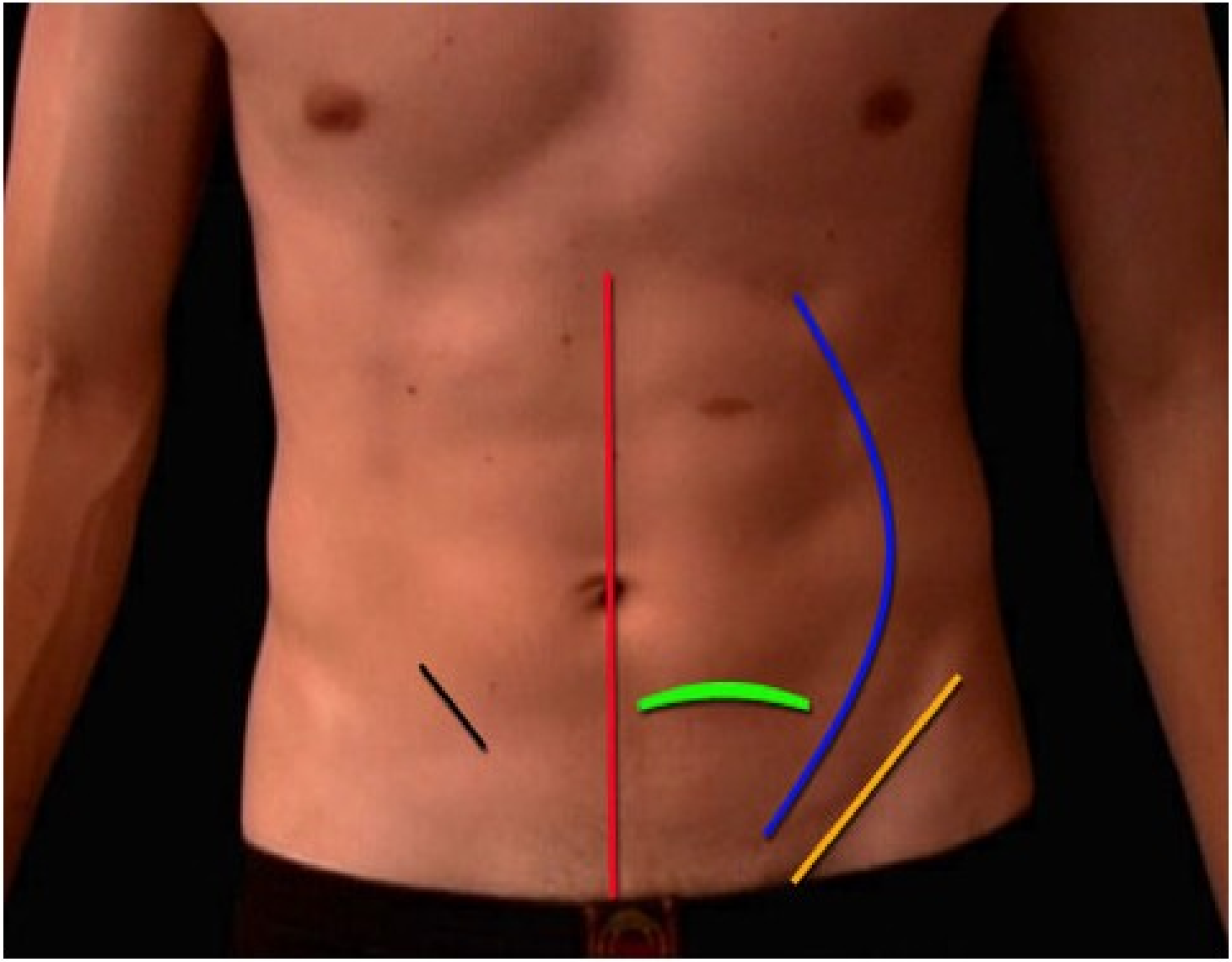
Surface Anatomy: Abdominal Regions



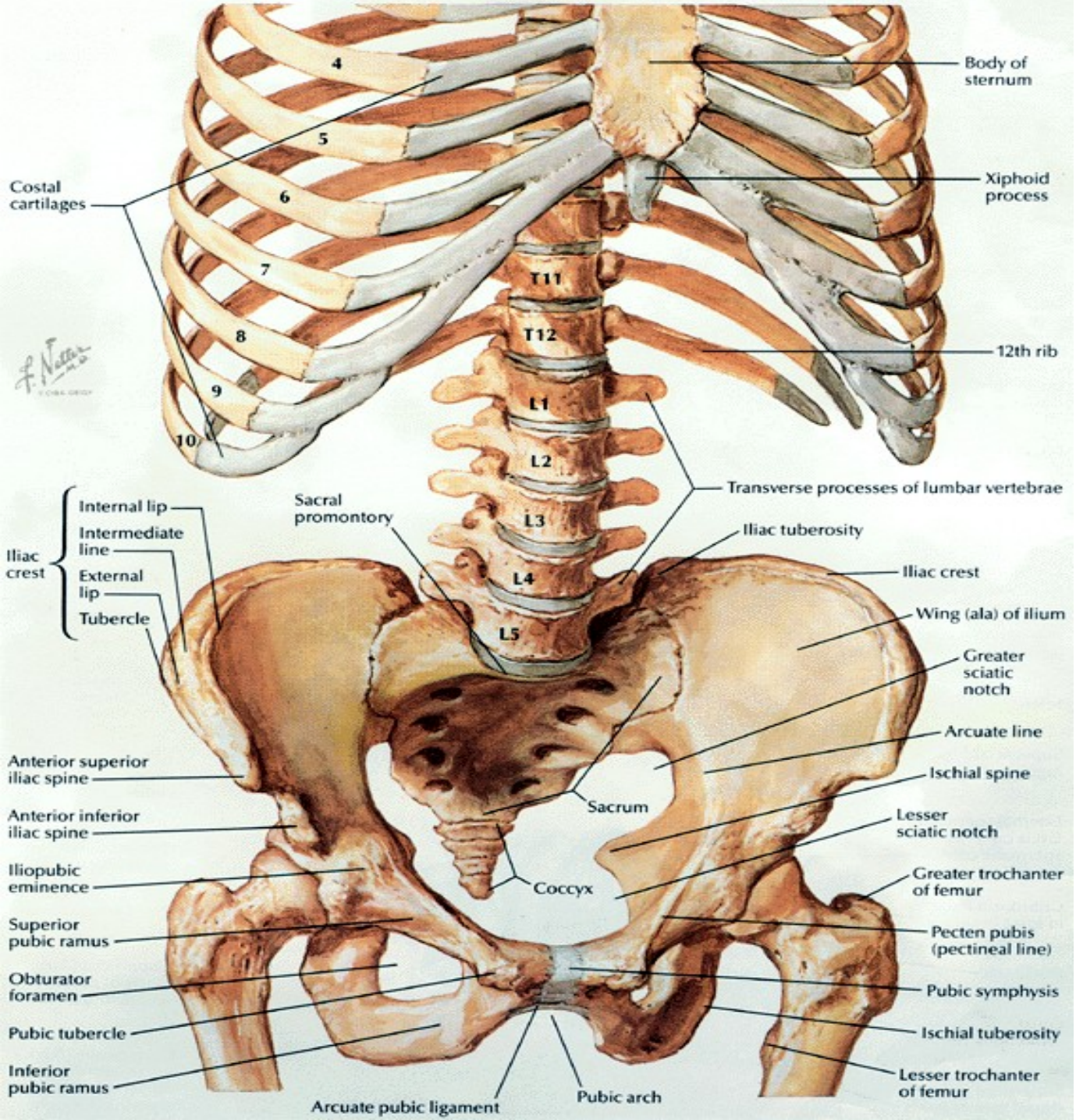
Surface Anatomy: Abdominal Regions



Surface Anatomy: Abdominal Wall



From left to right:
McBurney's incision, linea alba, arcuate line, linea semilunaris, inguinal ligament.


4
5
6
7
8
9
10
Costal cartilages
Body of sternum
Xiphoid process
12th rib
T11
T12
L1
L2
L3
L4
L5
Transverse processes of lumbar vertebrae
Iliac crest
Internal lip
Intermediate line
External lip
Tubercle
Sacral promontory
Iliac tuberosity
Iliac crest
Wing (ala) of ilium
Greater sciatic notch
Arcuate line
Ischial spine
Lesser sciatic notch
Greater trochanter of femur
Pecten pubis (pectineal line)
Pubic symphysis
Ischial tuberosity
Lesser trochanter of femur
Anterior superior iliac spine
Anterior inferior iliac spine
Iliopubic eminence
Superior pubic ramus
Obturator foramen
Pubic tubercle
Inferior pubic ramus
Sacrum
Coccyx
Arcuate pubic ligament
Pubic arch

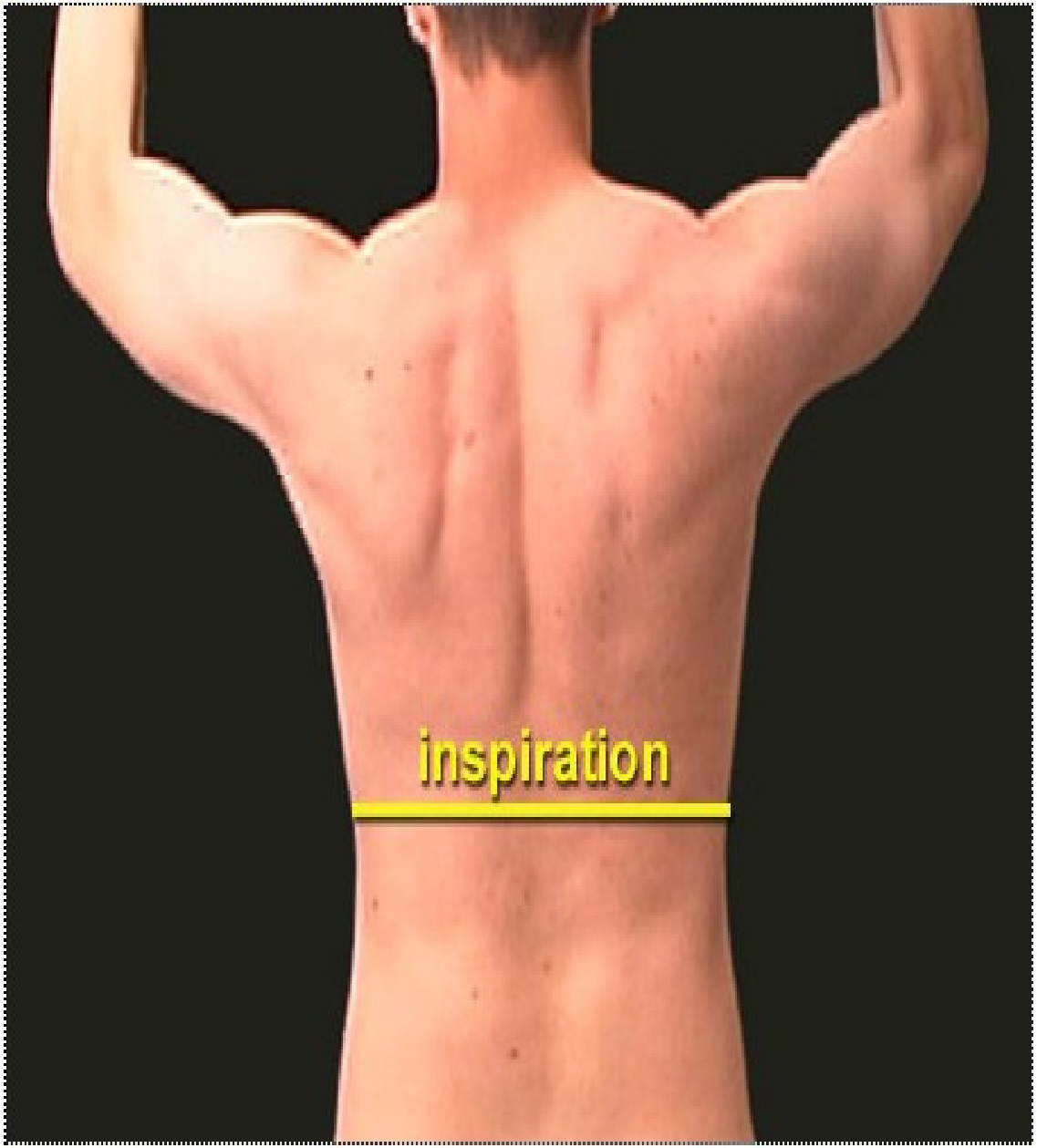
Muscles Used in Breathing

- External intercostals - Elevates ribs during inspirations
- Internal intercostals - Draws adjacent ribs together during forced expiration
- Diaphragm - pulls central tendon inferiorly during inspiration, thus increases vertical length of thorax

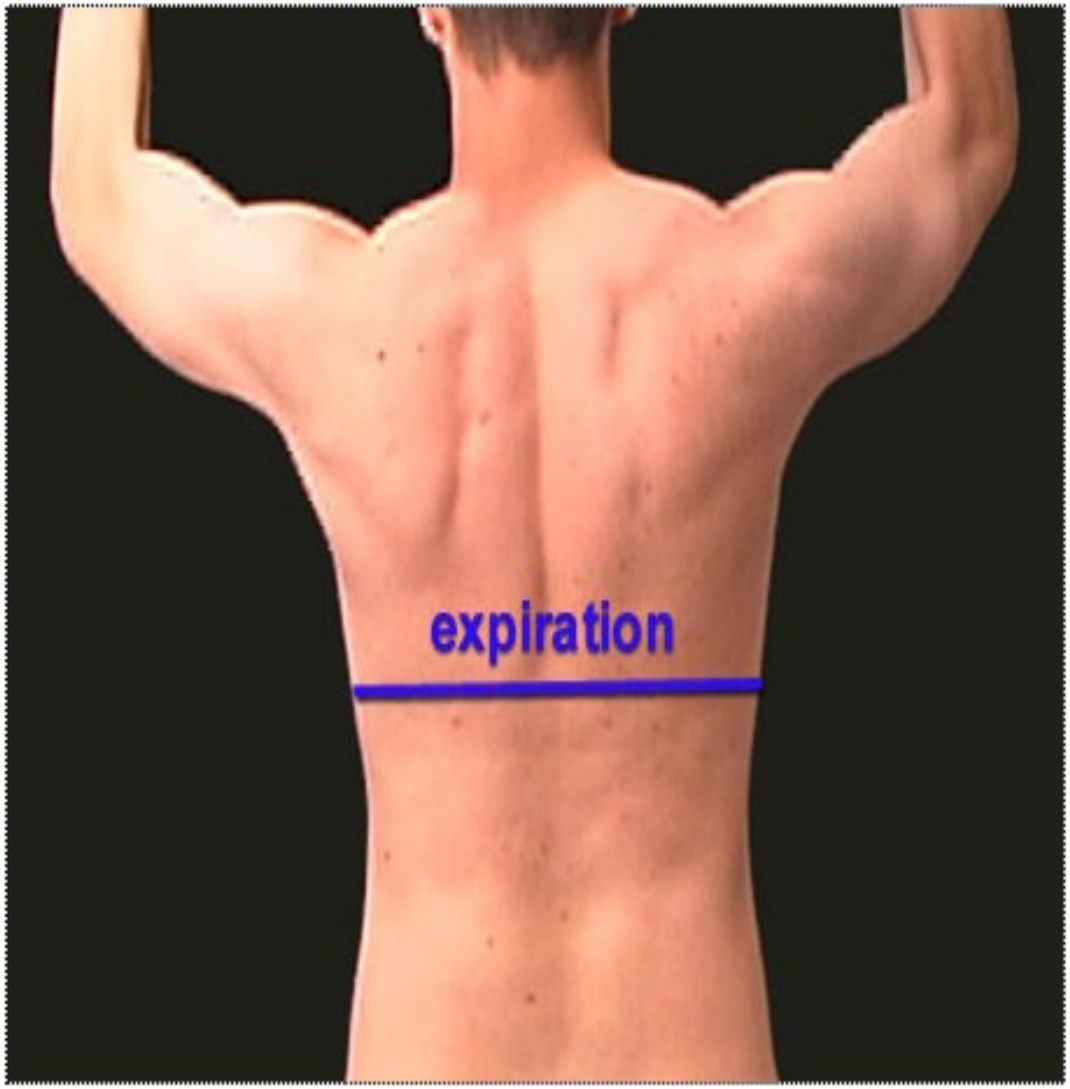
Diaphragm forms the Floor of the Thoracic Cavity

- Diaphragm separates the thoracic and abdominal cavities
  - Dome-shaped muscle
  - Top of “dome” is tendinous

Surface Anatomy: Diaphragmatic Dullness



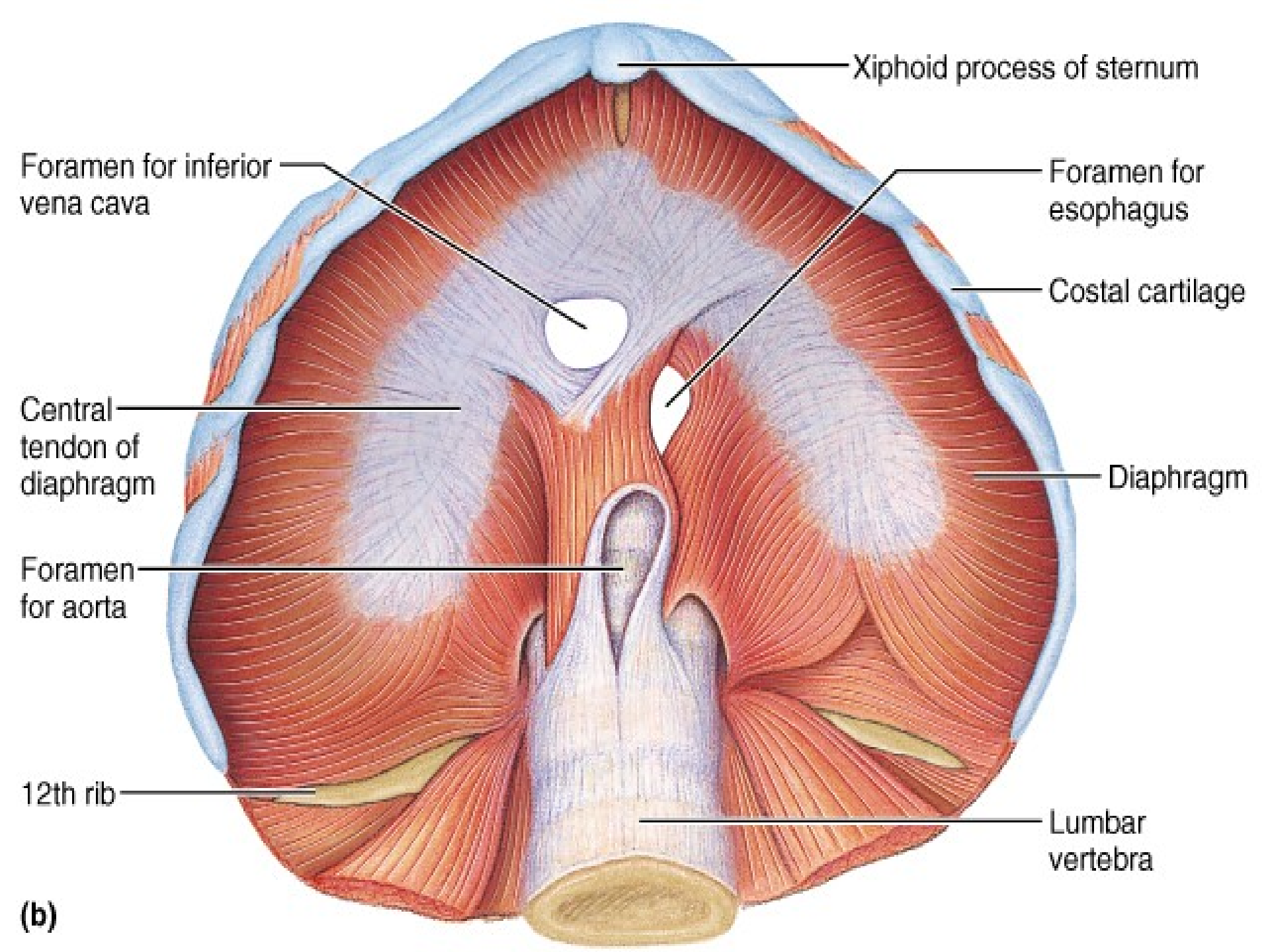
Surface Anatomy: Diaphragmatic Dullness

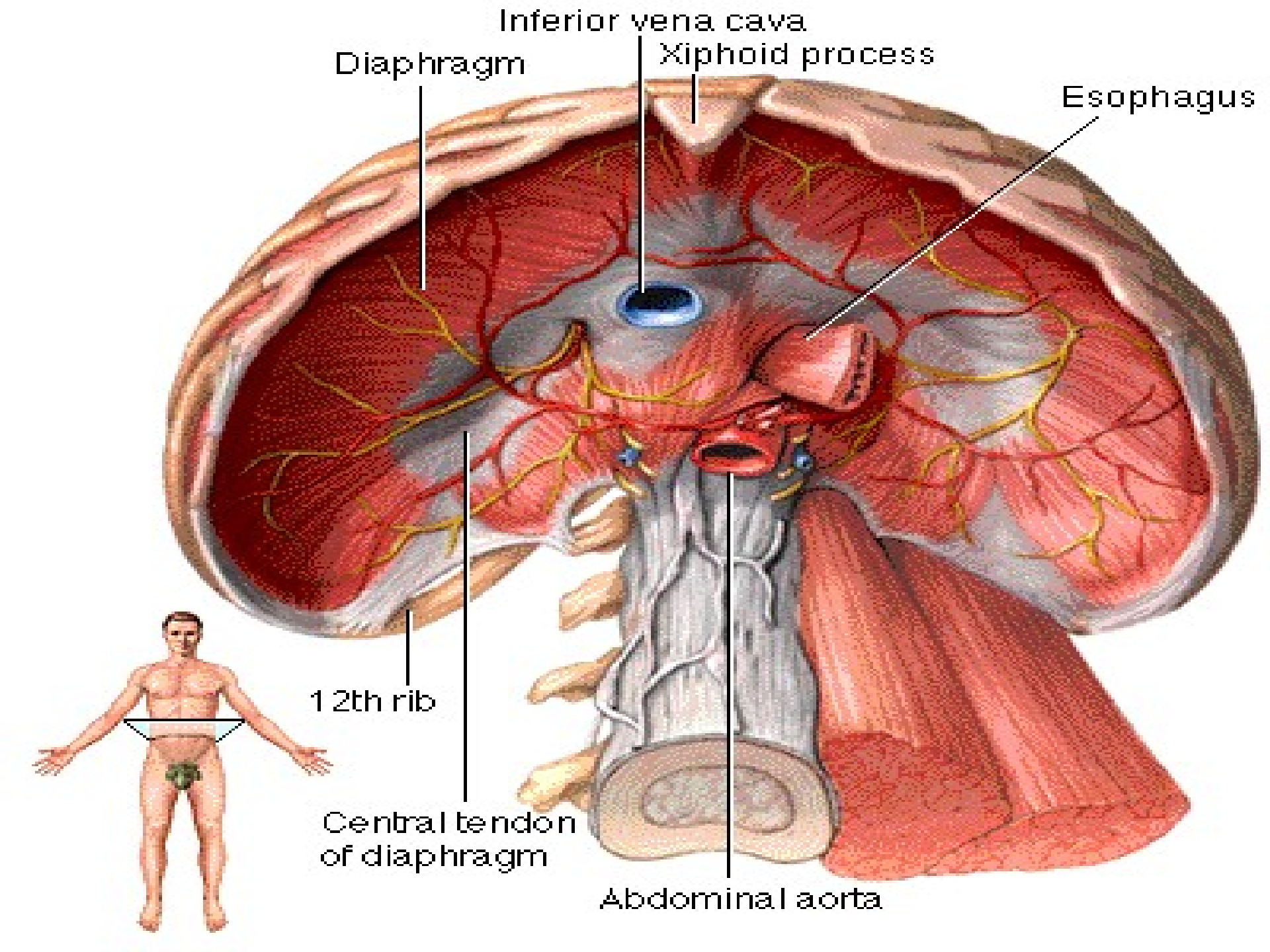


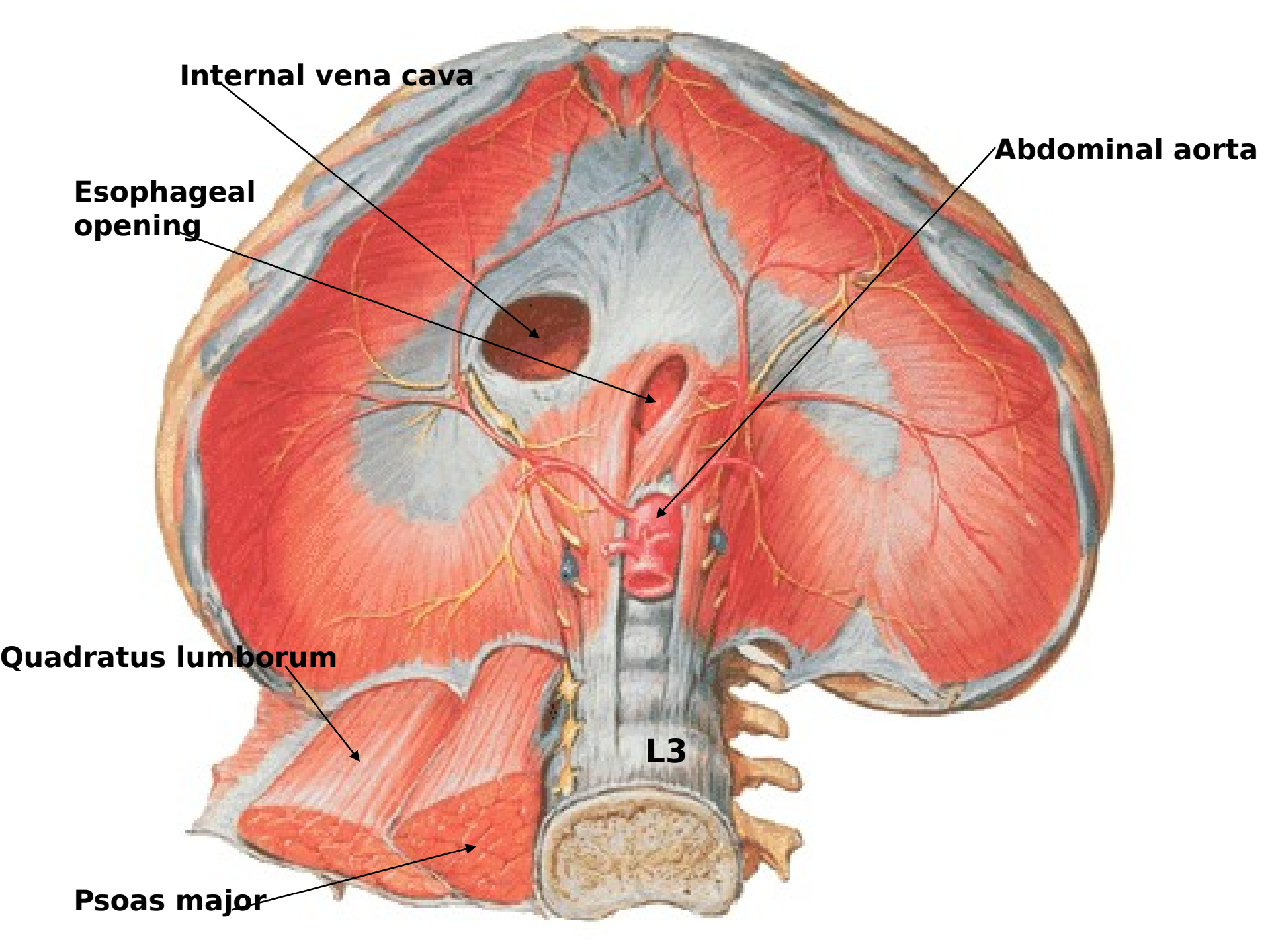
Note the level of dullness rises as more diaphragmatic muscle contacts the posterior abdominal wall.

DIAPHRAGM

- Attachment
  - Upper 3 lumbar vertebrae
  - Ribs 7 to 12
  - Xiphoid process
- Central tendon
  - Pierced by Aorta, Esophagus, Inferior vena cava
- Innervation: phrenic n (C_{3-5})

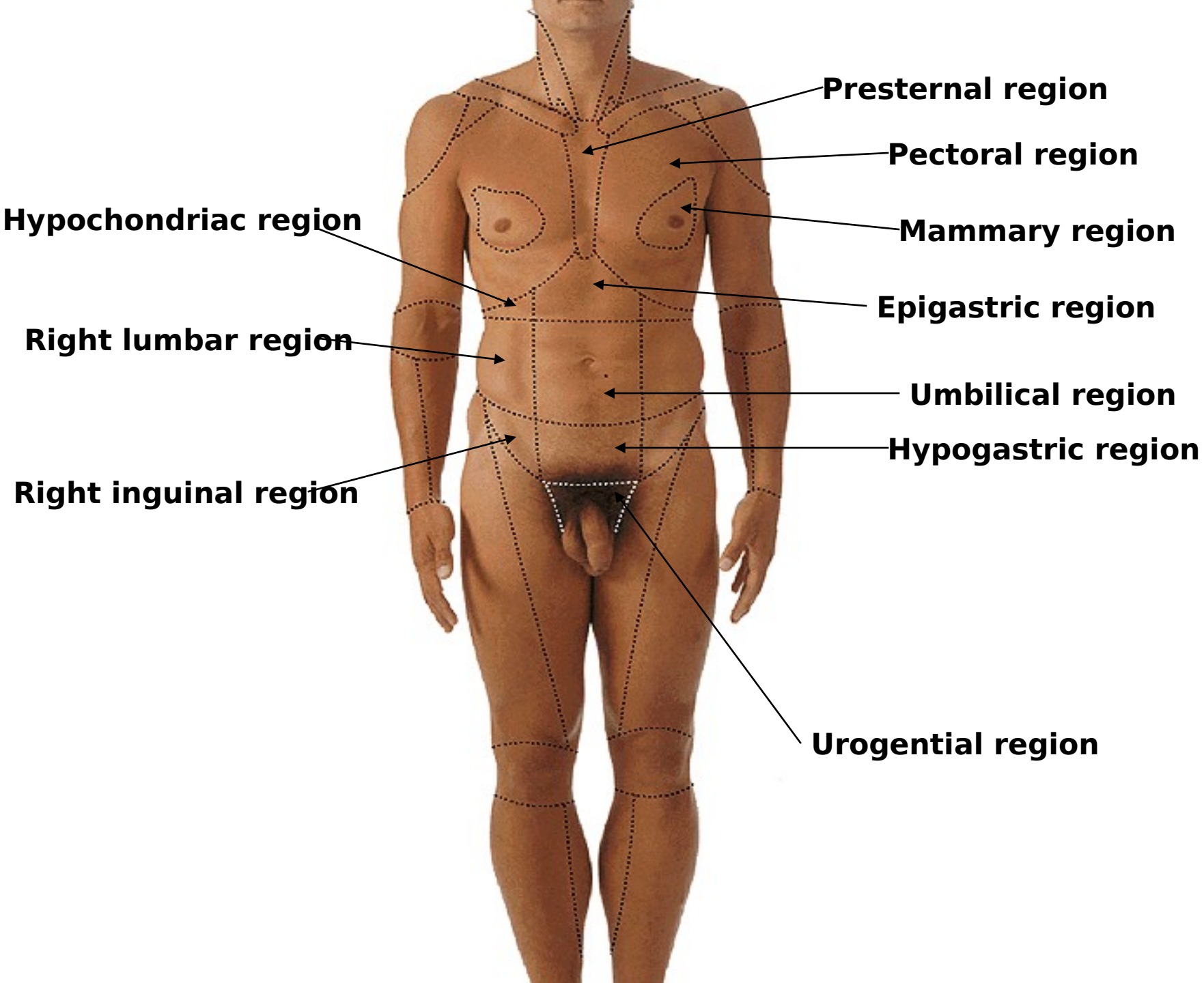

Xiphoid process of sternum
Foramen for inferior vena cava
Foramen for esophagus
Costal cartilage
Central tendon of diaphragm
Diaphragm
Foramen for aorta
12th rib
Lumbar vertebra
(b)

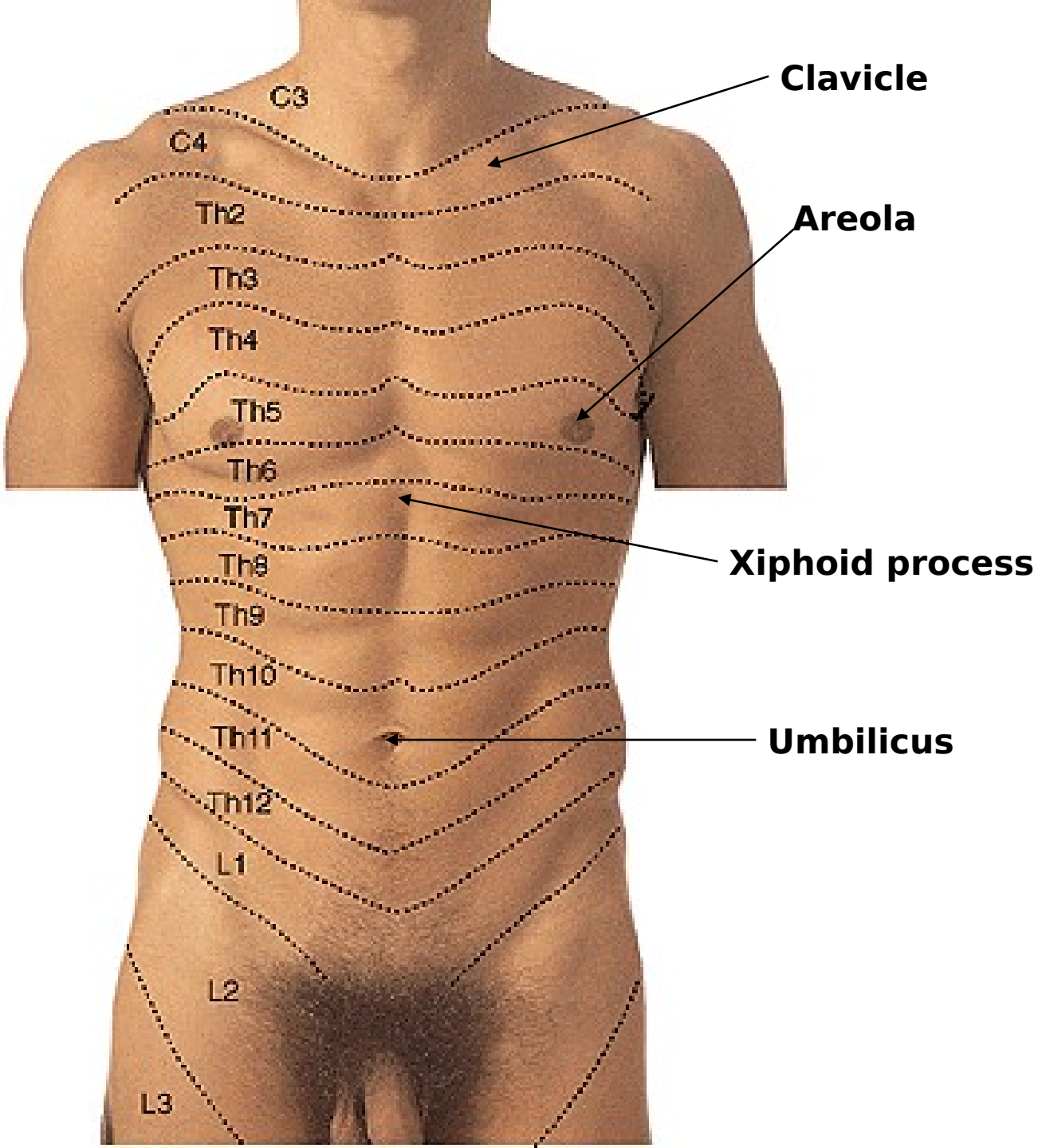

Inferior vena cava
Diaphragm
Xiphoid process
Esophagus
12th rib
Central tendon
of diaphragm
Abdominal aorta

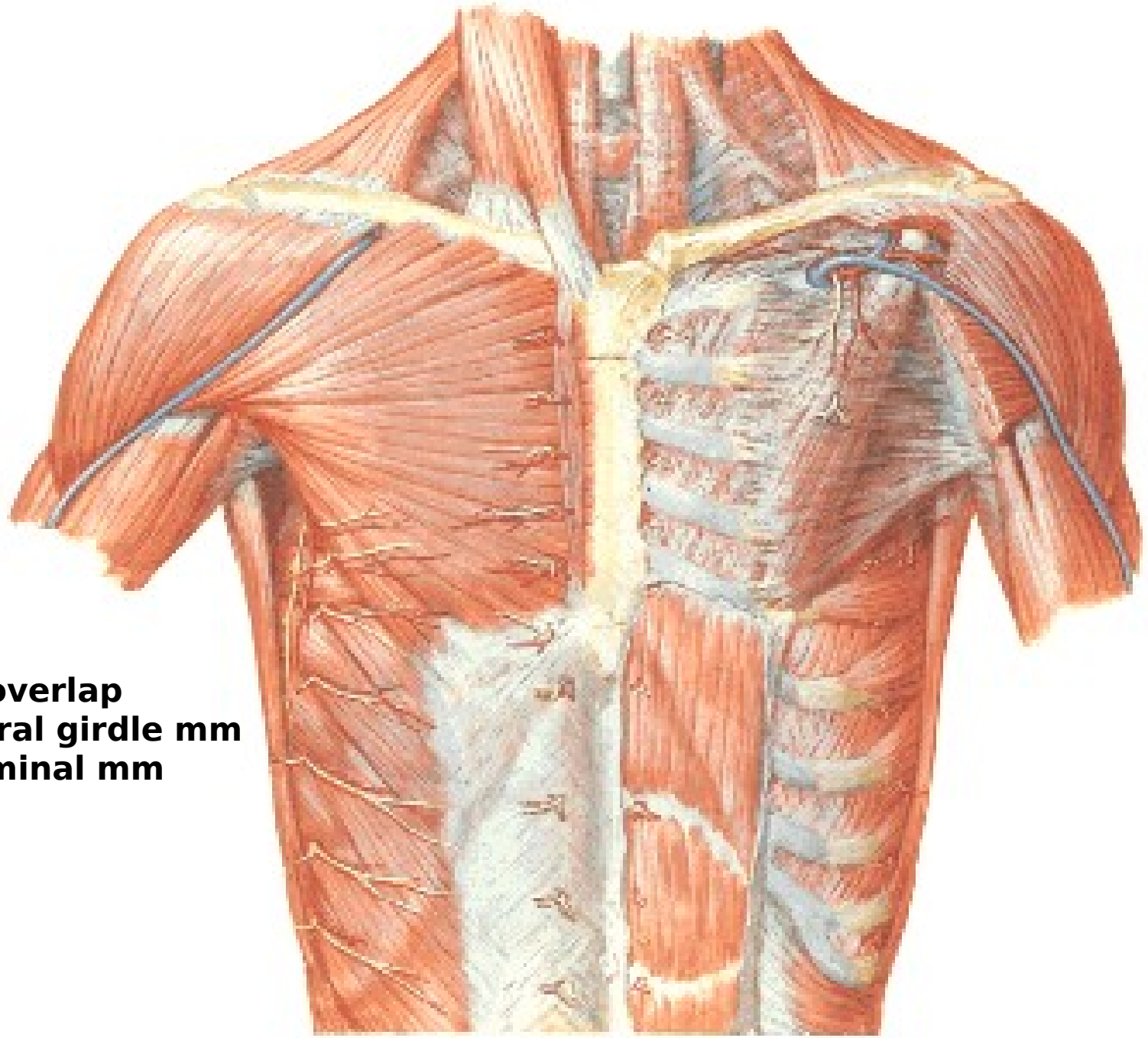

Internal vena cava
Abdominal aorta
Esophageal opening
Quadratus lumborum
L3
Psoas major

TRUNK MUSCLES: ABDOMEN

REVIEW OF TRUNK SURFACE ANATOMY


Presternal region
Pectoral region
Hypochondriac region
Mammary region
Epigastric region
Right lumbar region
Umbilical region
Hypogastric region
Right inguinal region
Urogential region

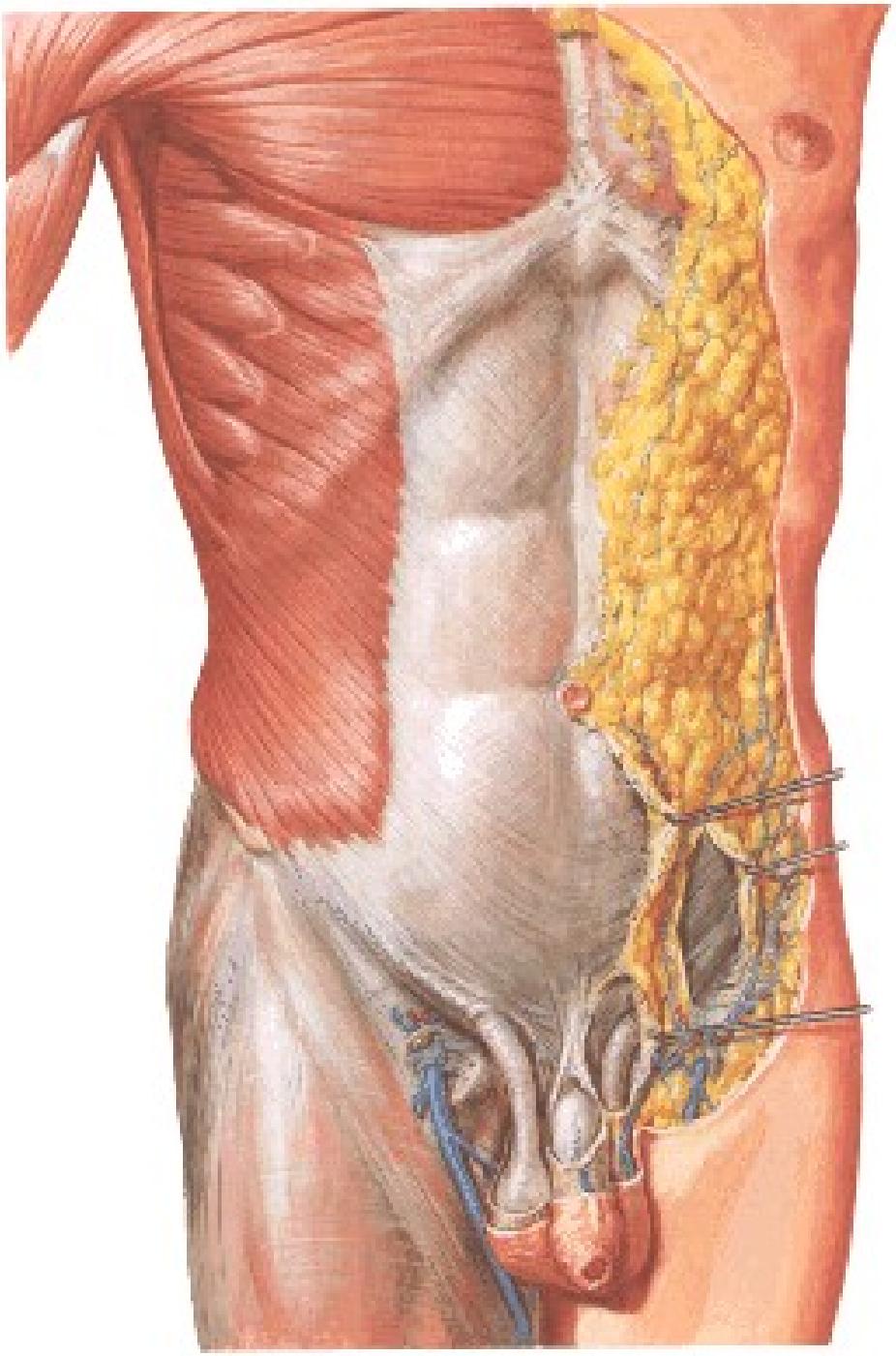

C3
C4
Th2
Th3
Th4
Th5
Th6
Th7
Th8
Th9
Th10
Th11
Th12
L1
L2
L3
Clavicle
Areola
Xiphoid process
Umbilicus



Muscle overlap
- **pectoral girdle mm**
- **abdominal mm**

ABDOMINAL LAYERS

- Skin
- Superficial fascia
  - Camper’s fascia
  - Scarpa’s fascia
- Deep fascia
- Muscle layers
- Transversalis fascia
- Peritoneum

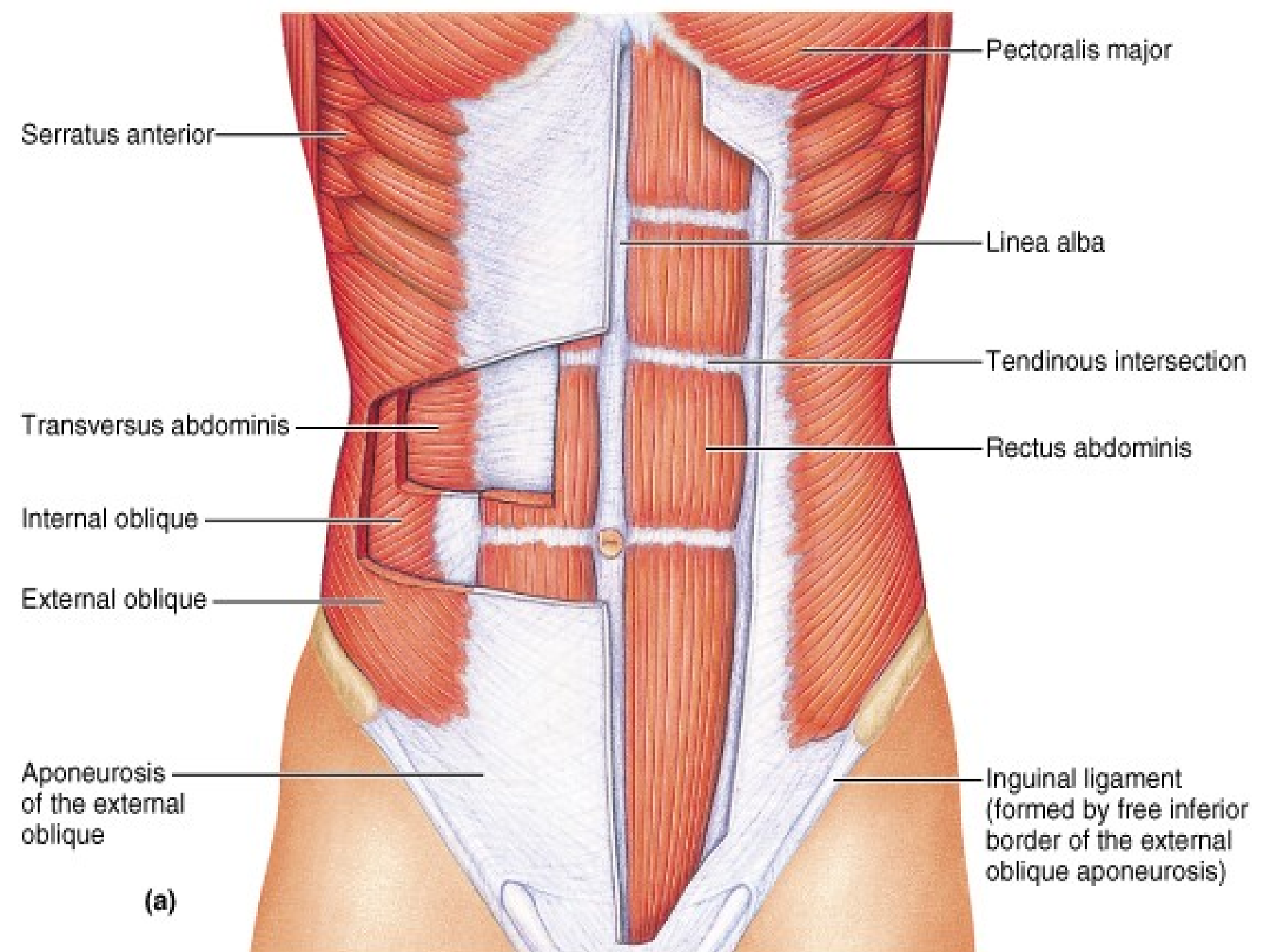


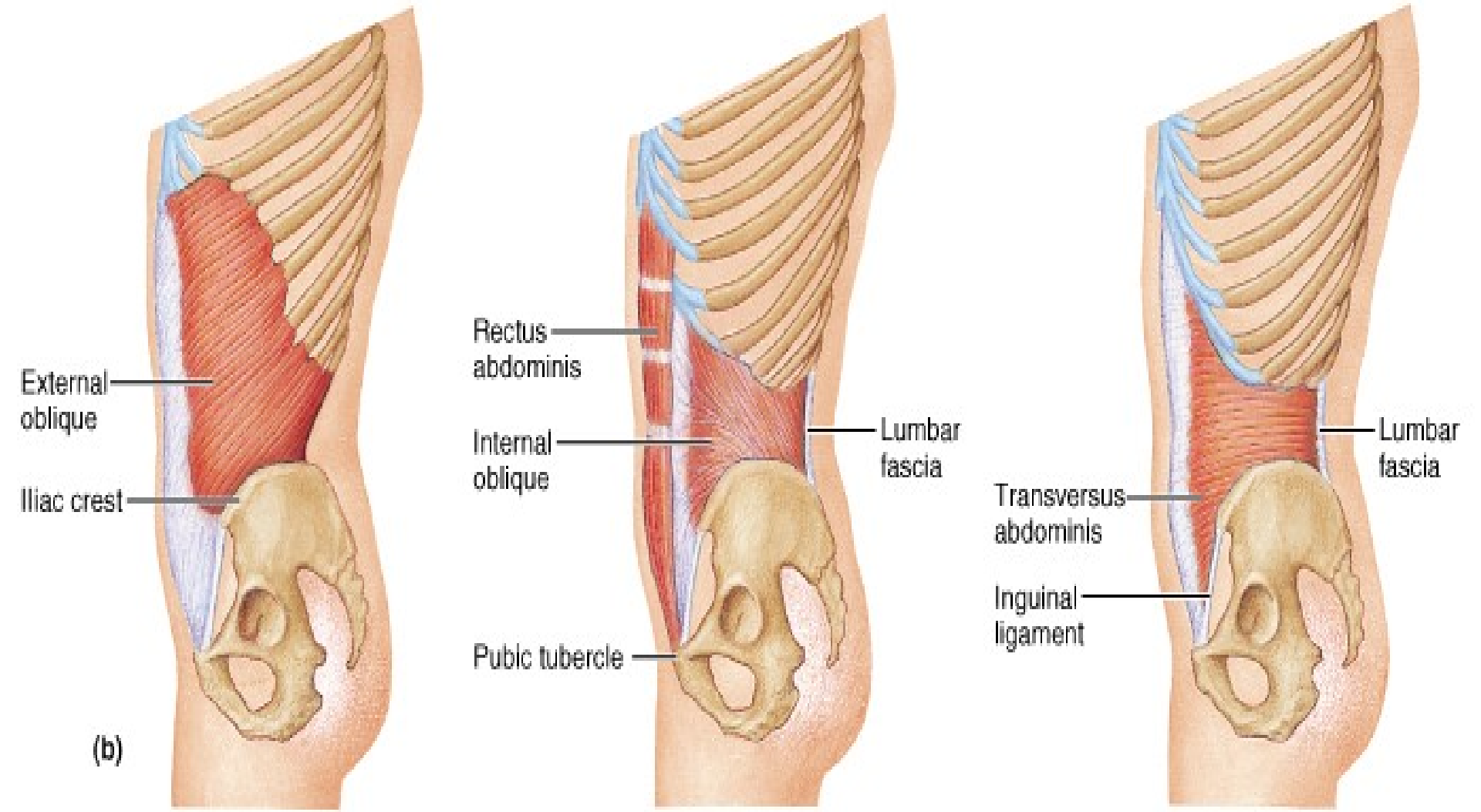
ABDOMINAL MUSCLE LAYERS

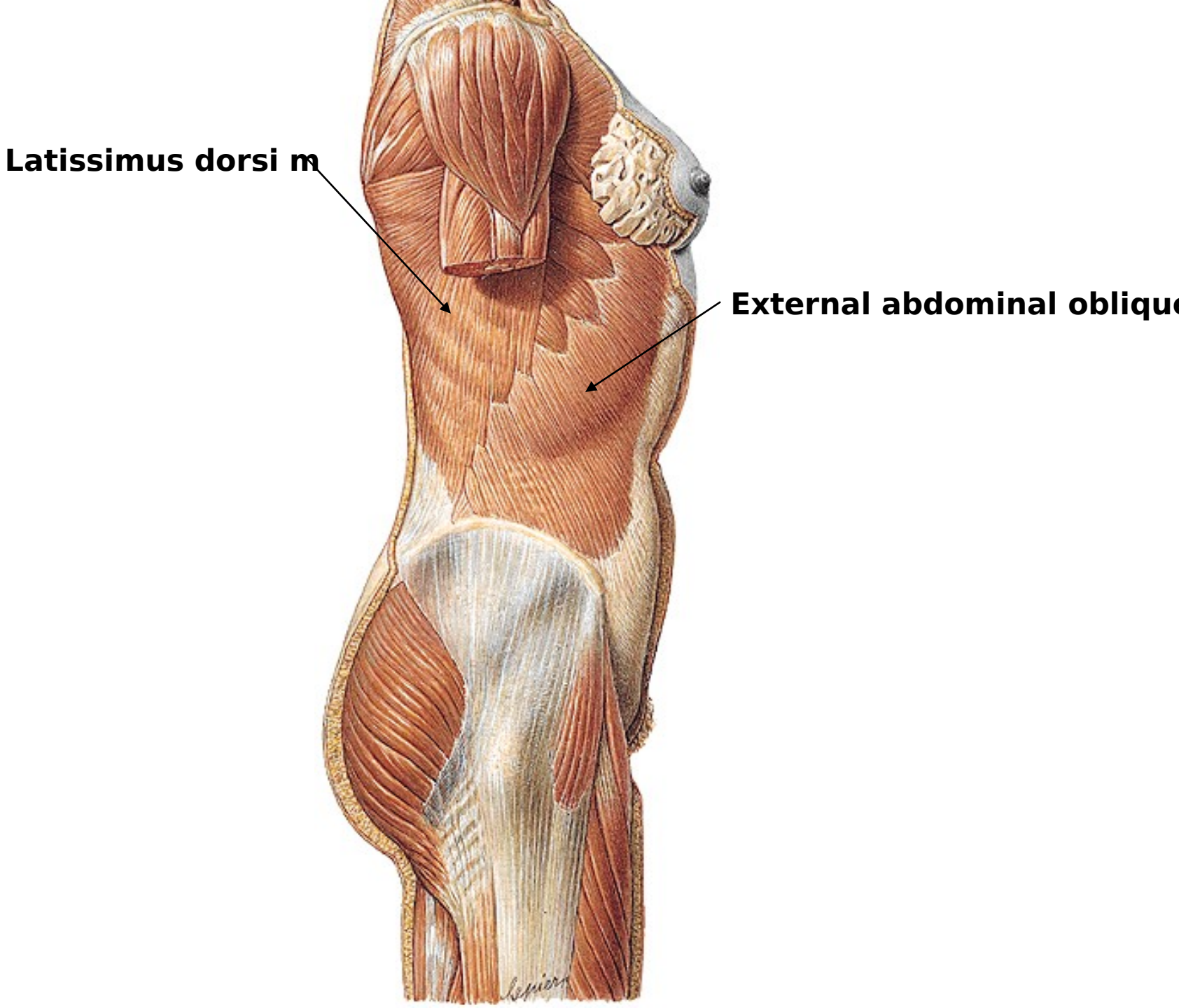
- External oblique (EO)
- Internal oblique (IO)
- Transversus abdominis (TA)
- Rectus abdominis (RA)
  - Linea alba

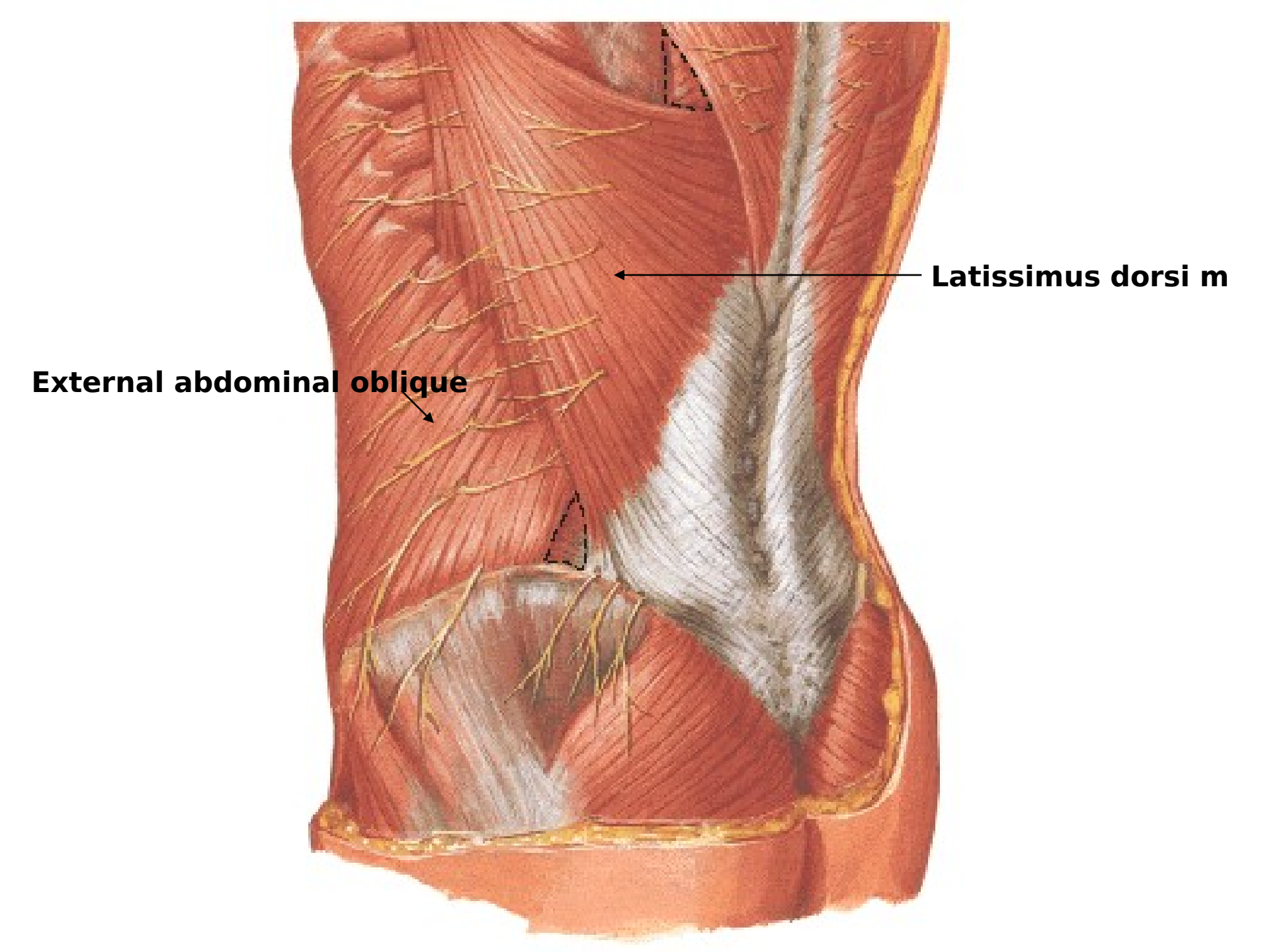
Muscles That Act On The Abdominal Wall

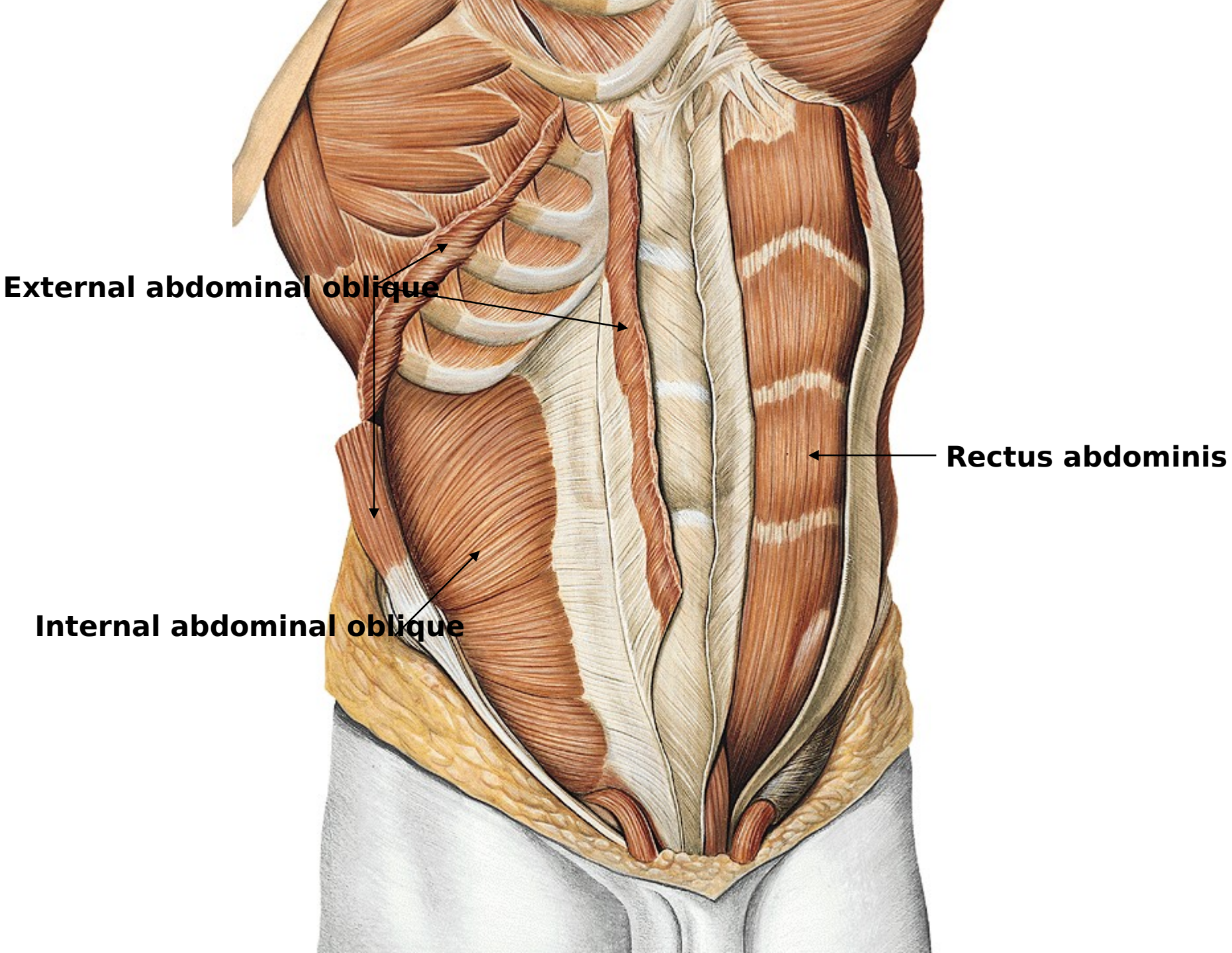
- Rectus abdominis -Flexes vertebral column & compresses abdomen
- External & Internal oblique -Compresses & lateral bend & rotates vertebral column
- Transversus abdominis -Compresses abdomen

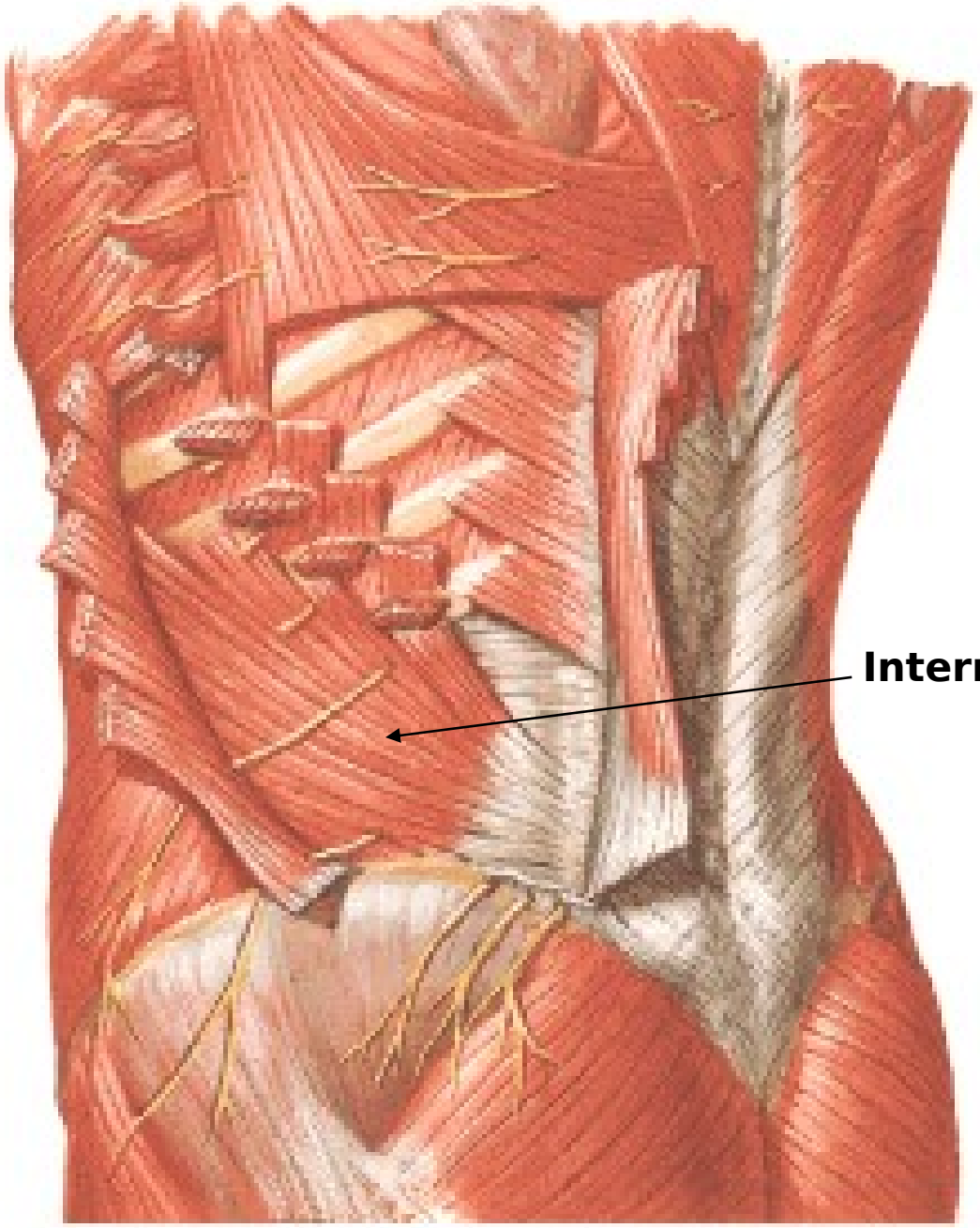

Pectoralis major
Serratus anterior
Linea alba
Tendinous intersection
Transversus abdominis
Rectus abdominis
Internal oblique
External oblique
Aponeurosis of the external oblique
Inguinal ligament (formed by free inferior border of the external oblique aponeurosis)
(a)

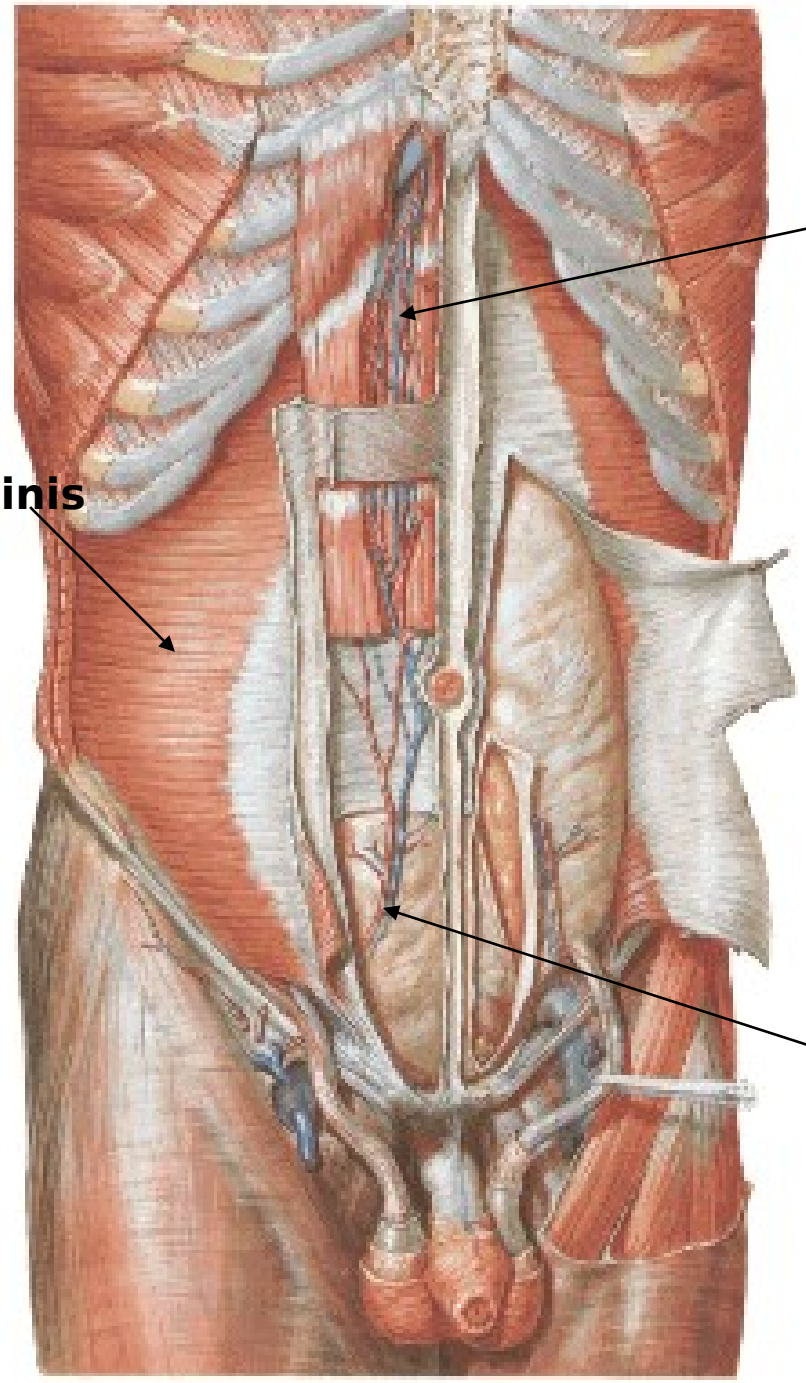

External oblique
Iliac crest
(b)
Rectus abdominis
Internal oblique
Lumbar fascia
Pubic tubercle
Transversus abdominis
Inguinal ligament
Lumbar fascia

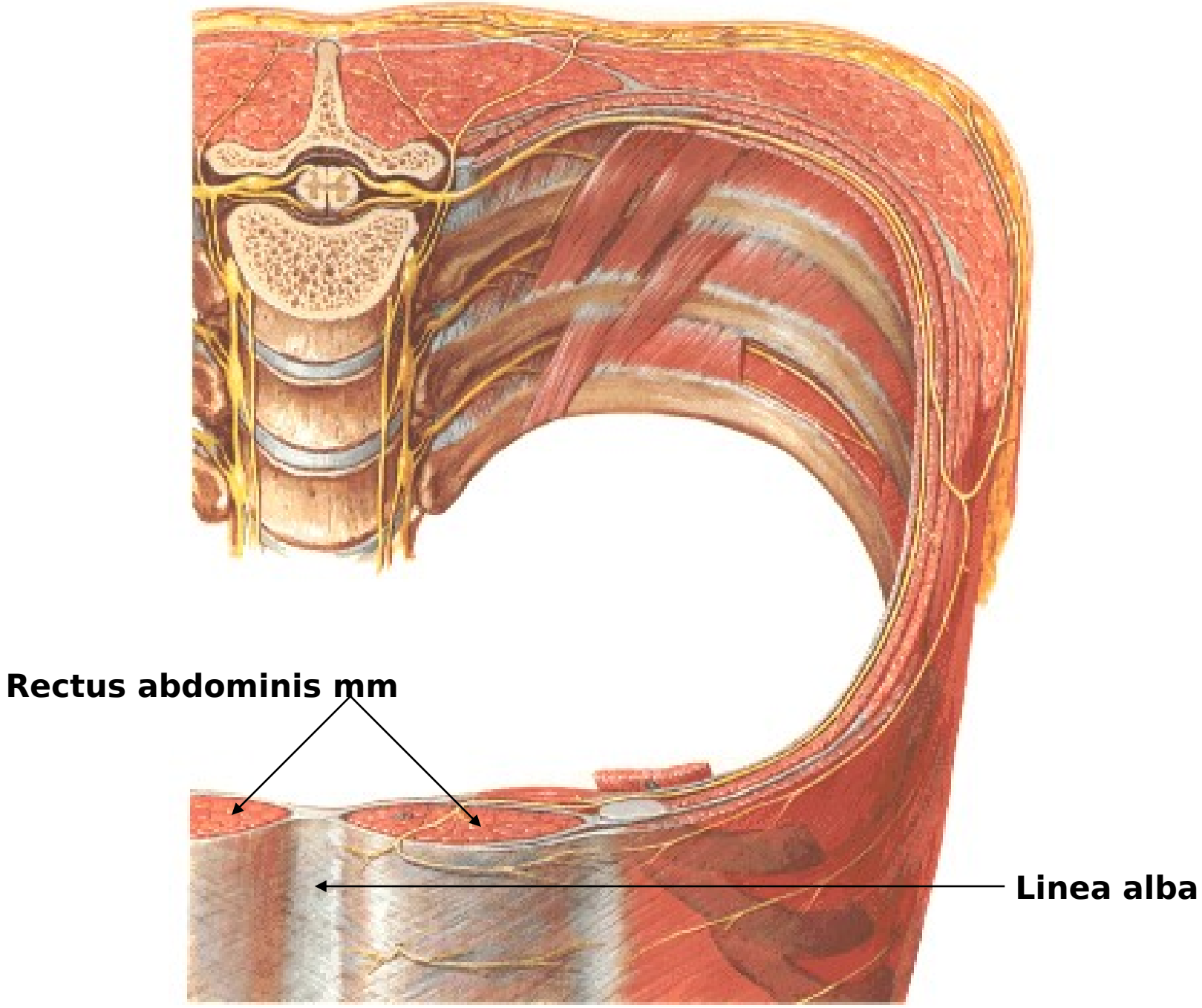

Latissimus dorsi m
External abdominal oblique

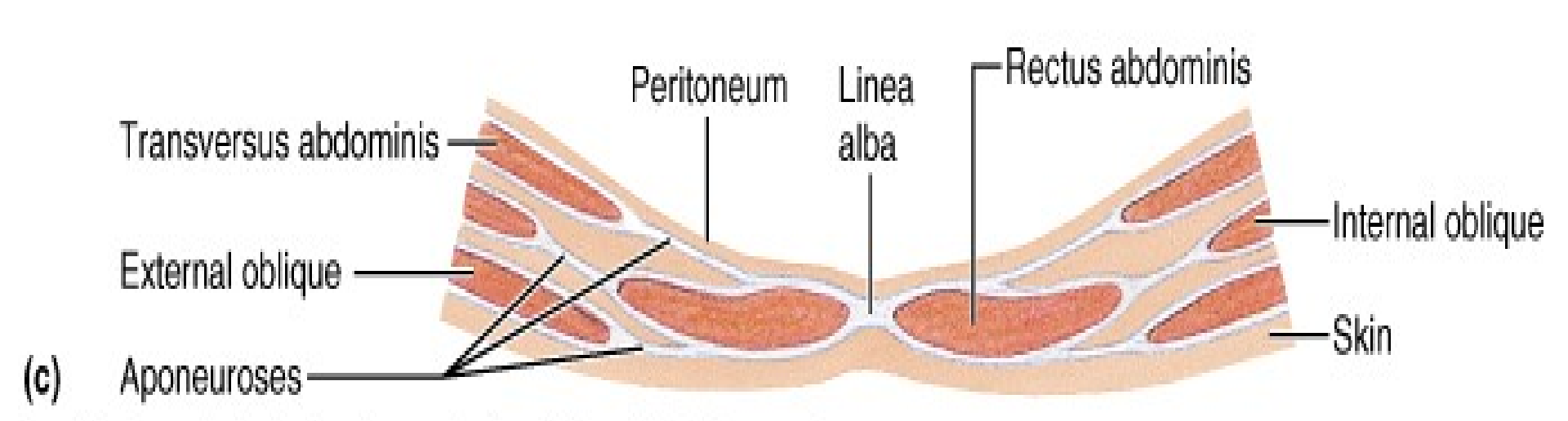

Latissimus dorsi m
External abdominal oblique

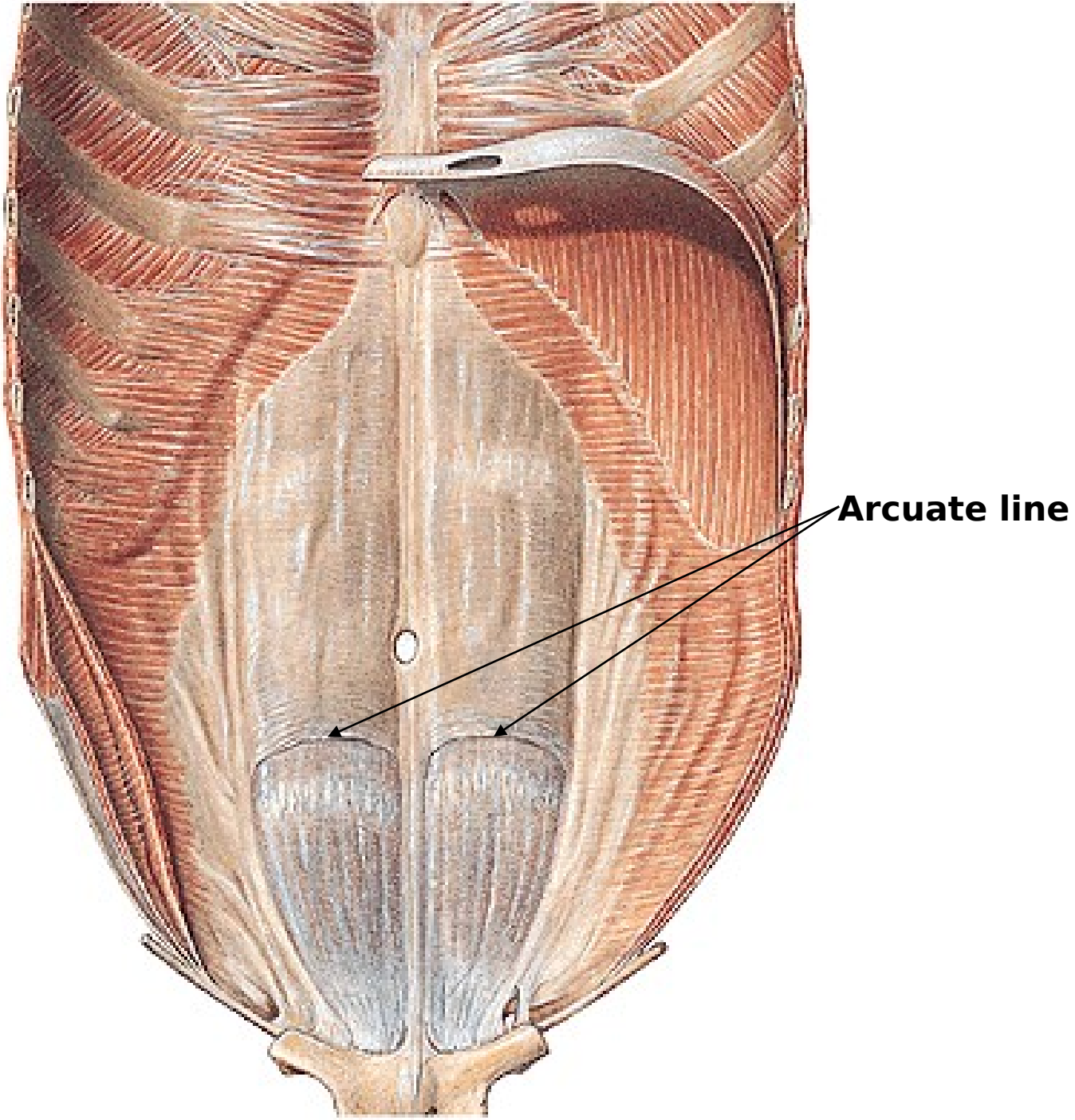

External abdominal oblique
Rectus abdominis
Internal abdominal oblique


Internal abdominal obli

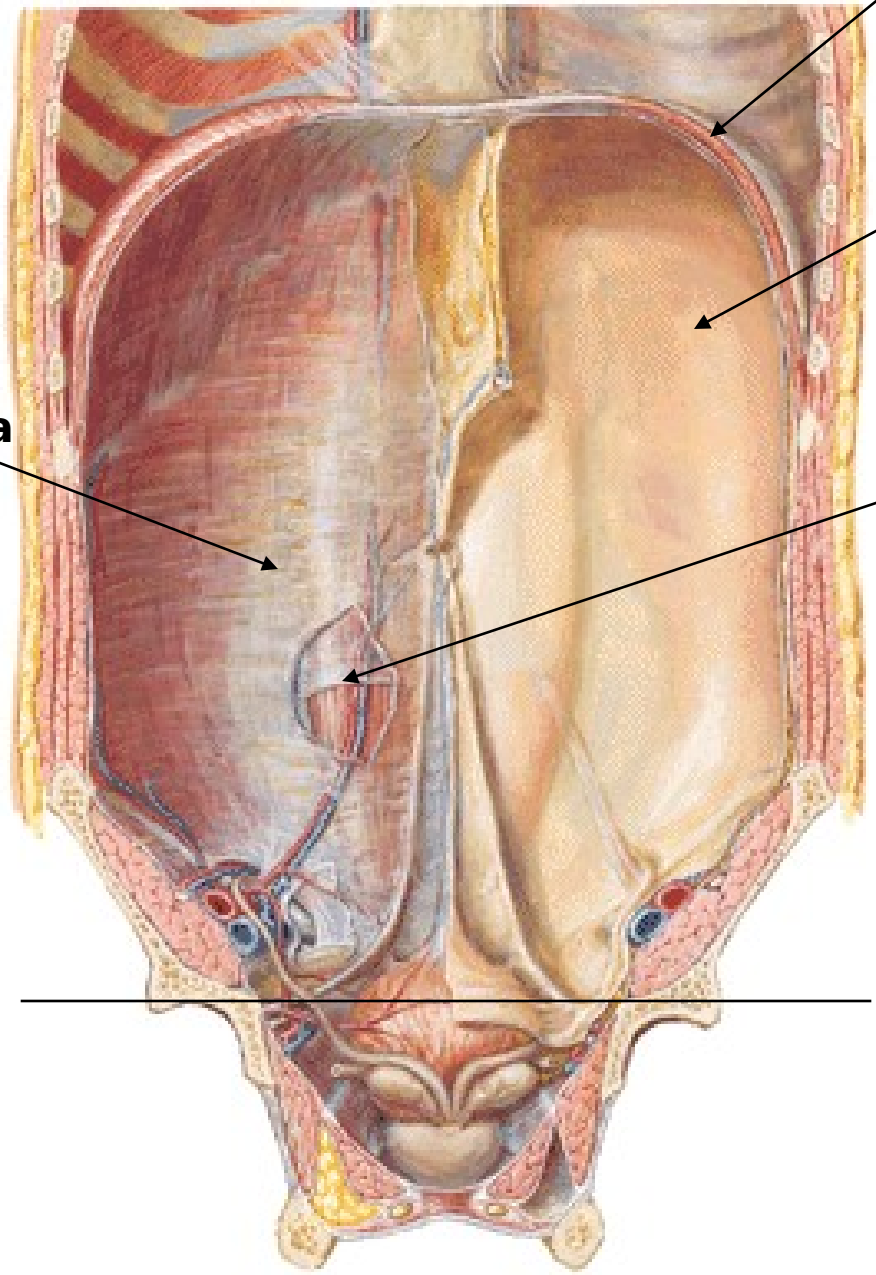

Superior epigastric a
Transversus abdominis
Inferior epigastric a &

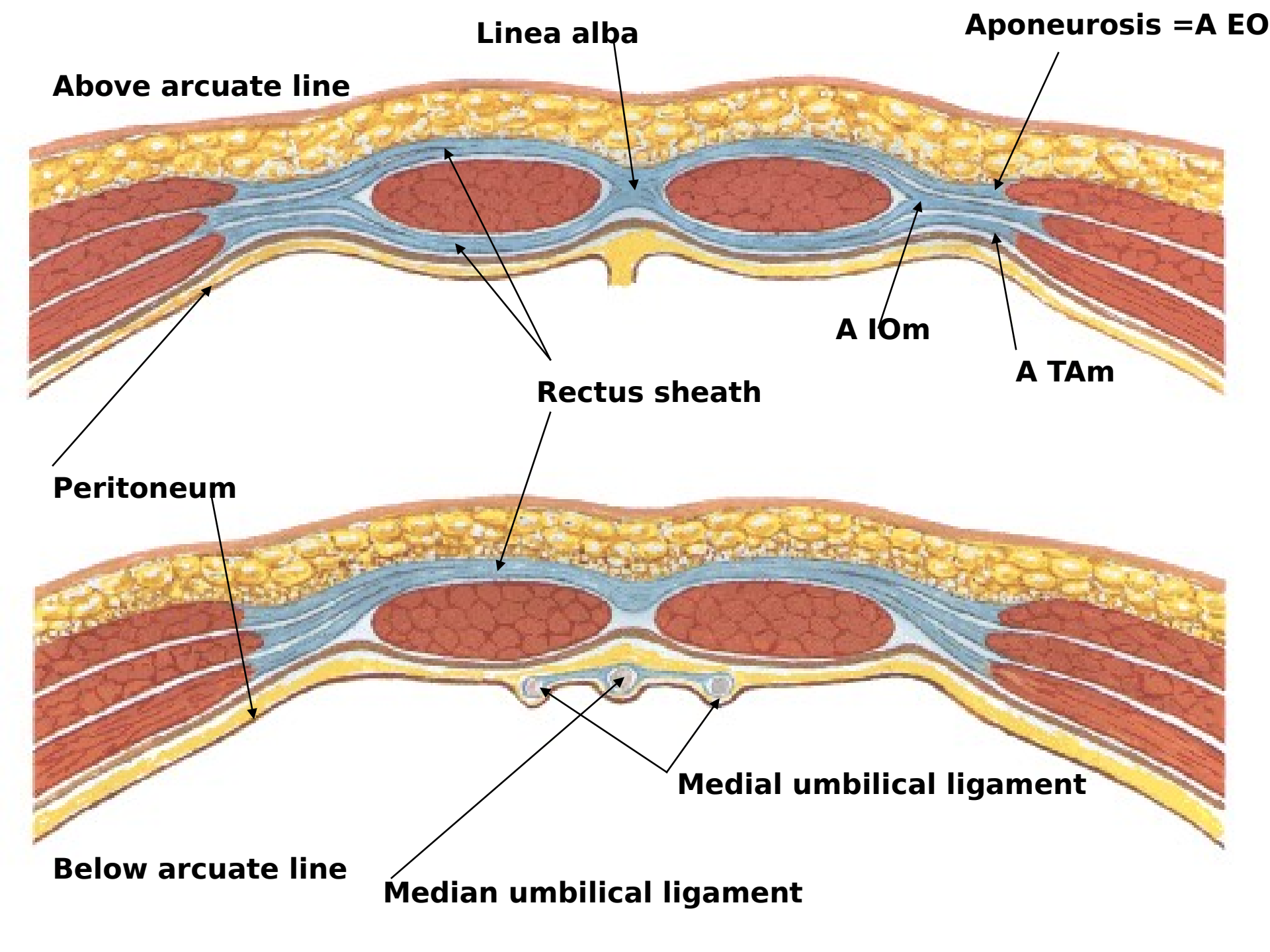

Rectus abdominis mm
Linea alba

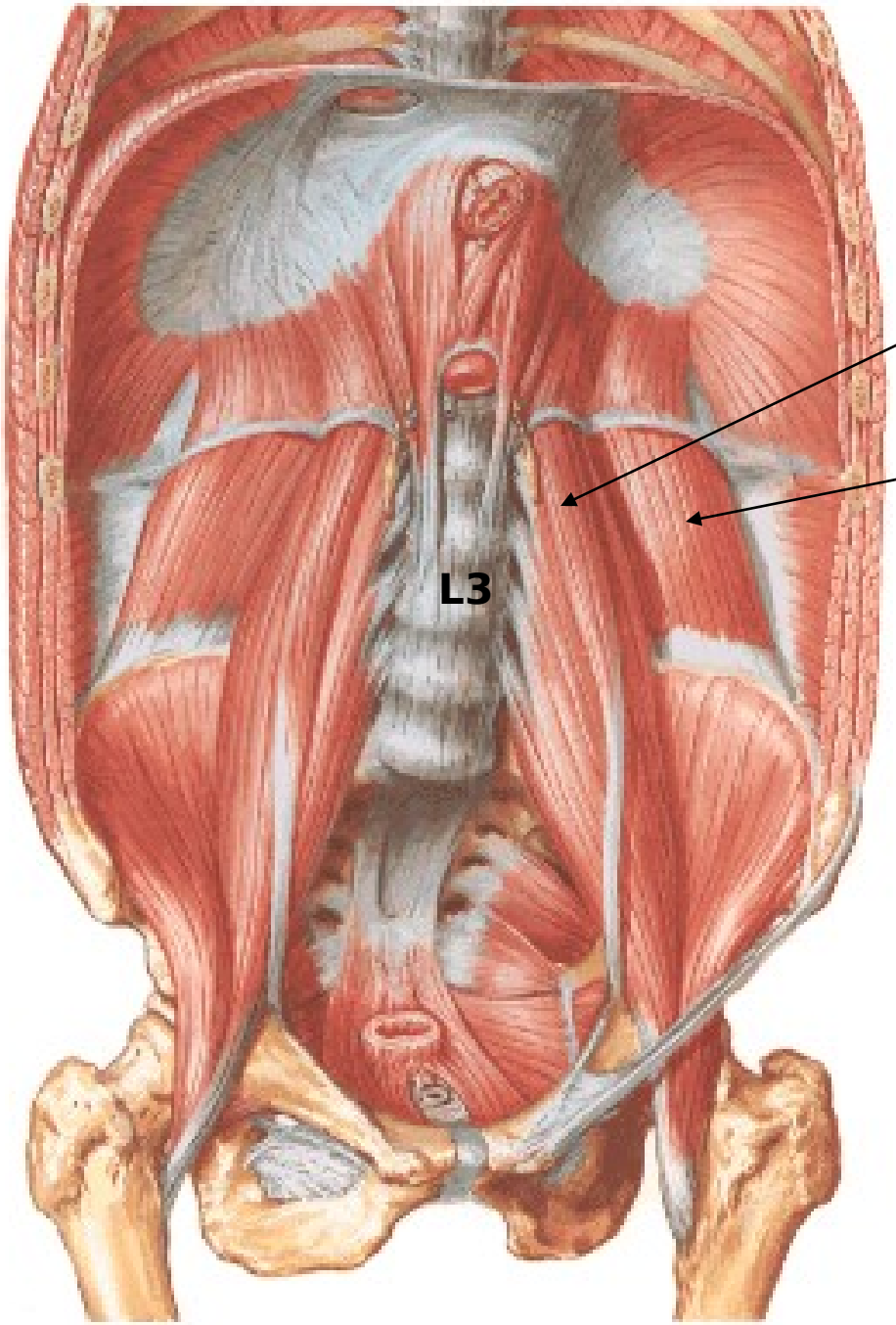

Peritoneum
Linea alba
Rectus abdominis
Transversus abdominis
Internal oblique
External oblique
Skin
(c)
Aponeuroses


Arcuate line

Internal View

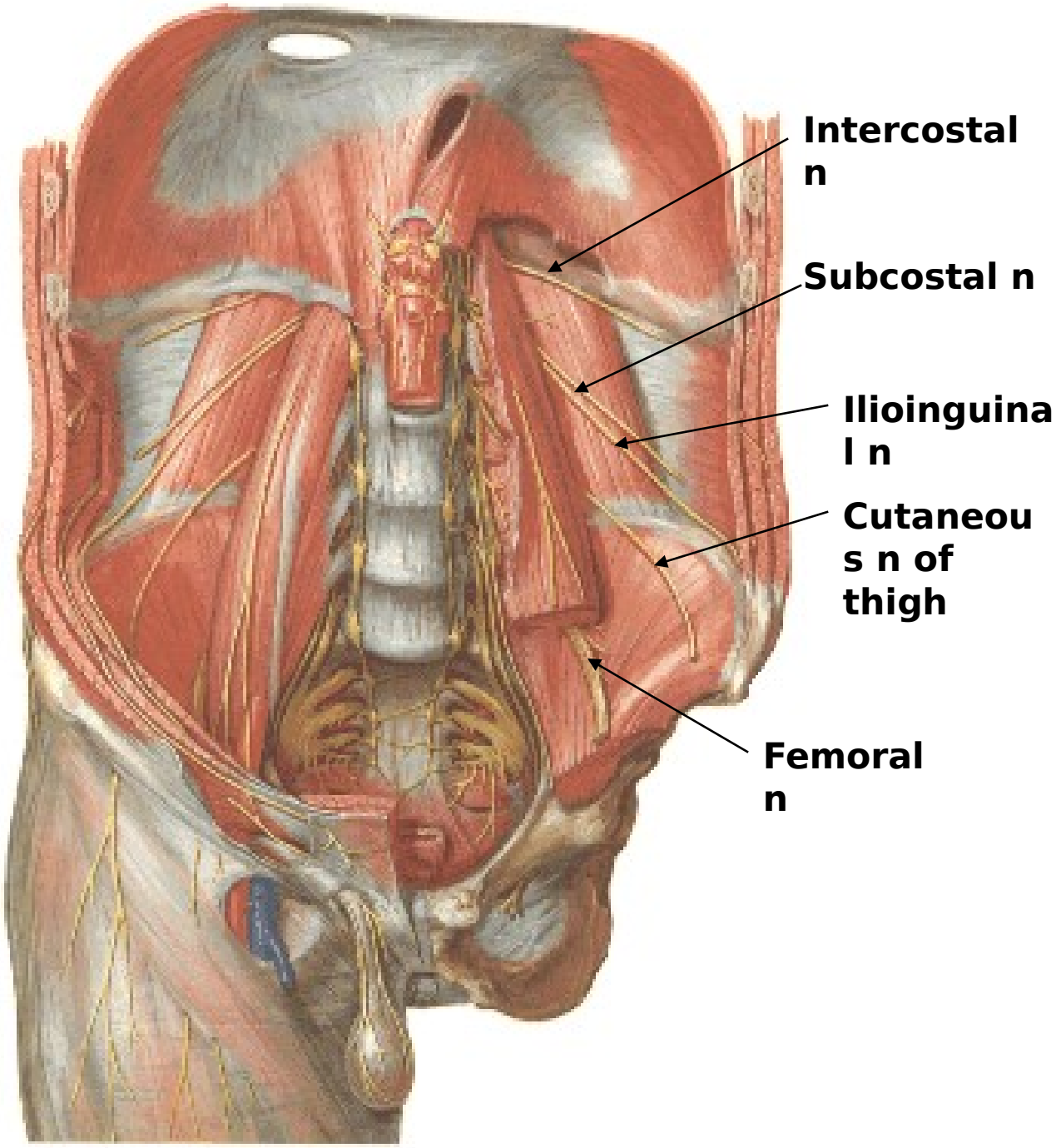



Linea alba
Aponeurosis =A EO
Above arcuate line
A IOm
A TAm
Rectus sheath
Peritoneum
Medial umbilical ligament
Below arcuate line
Median umbilical ligament


Psoas
Quadratus lumboru
L3

Innervation

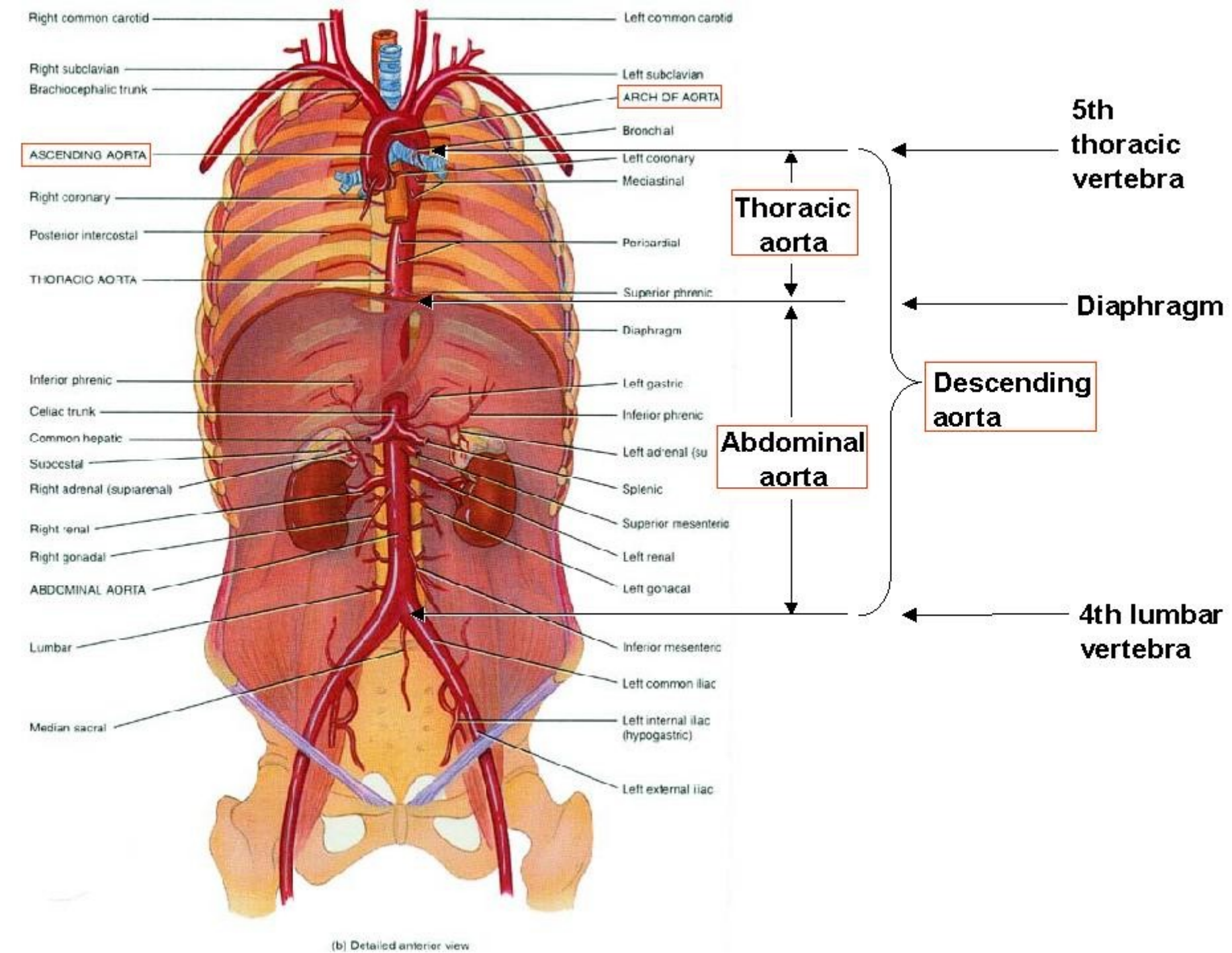
- EO - inferior six thoracic nn & subcostal n
- IO & TA - inferior six thoracic nn & first lumbar nn
- RA - inferior six thoracic nn

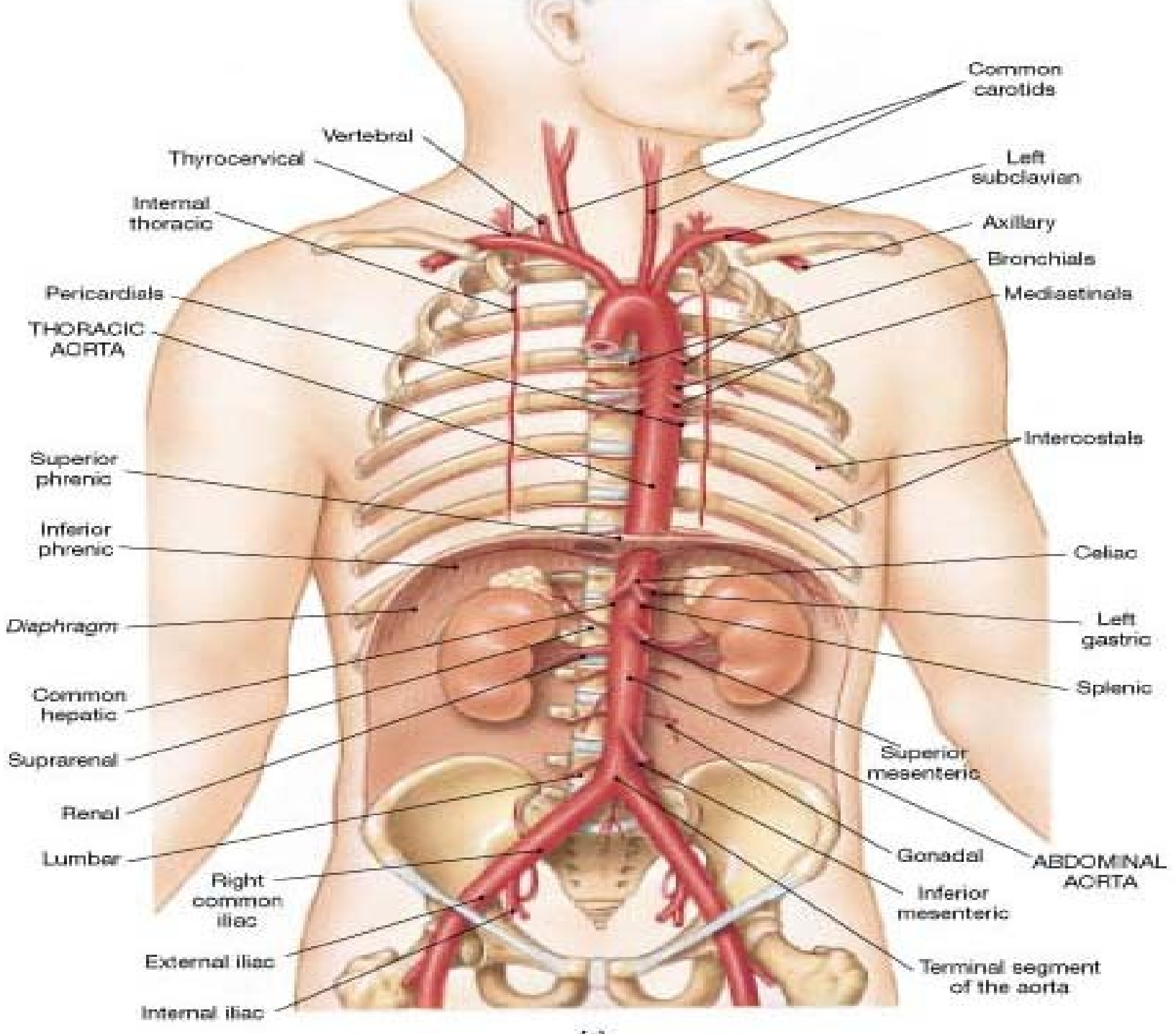

Intercostal n
Subcostal n
Ilioinguinal n
Cutaneous n of thigh
Femoral n

BLOOD VESSELS

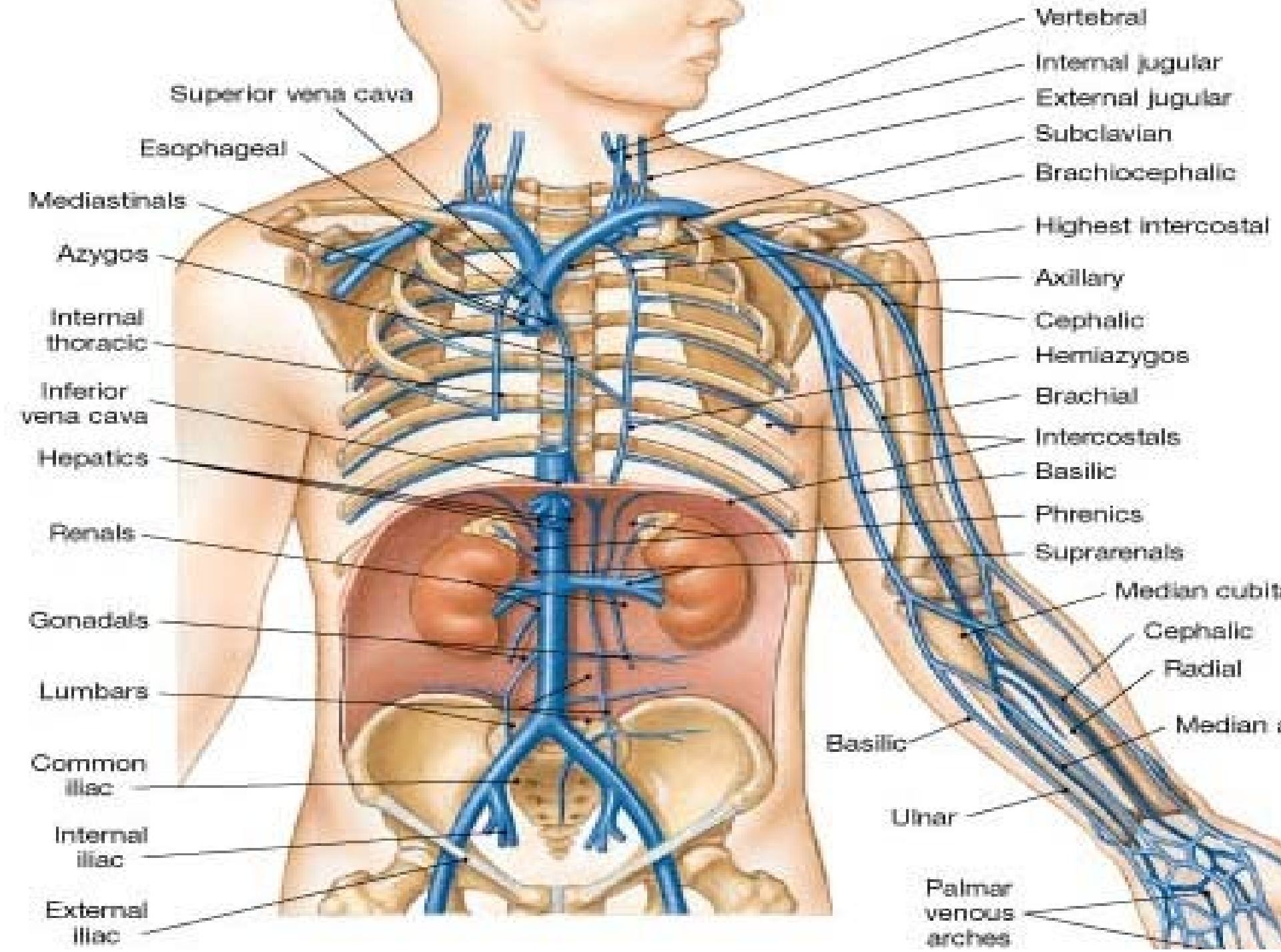
ABDOMINAL VESSELS

- Aorta
  - Pre/Paravertebral branches
- Iliac aa
  - Int/External iliac aa
- Inferior epigastric
- Superior epigastric

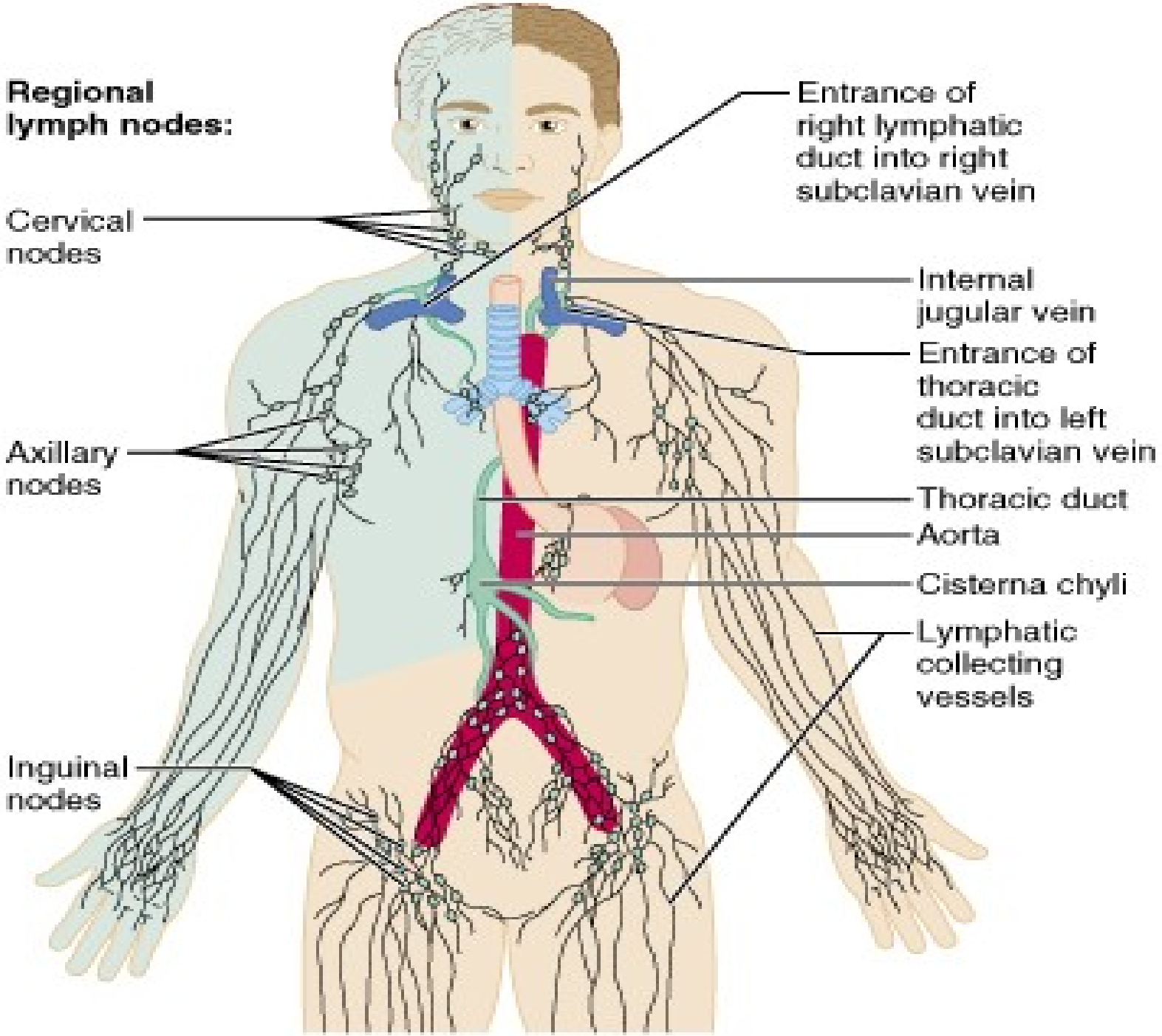

Right common carotid
Left common carotid
Right subclavian
Brachiocephalic trunk
Left subclavian
ARCH OF AORTA
Bronchial
ASCENDING AORTA
Left coronary
Meciastinal
Right coronary
Posterior intercostal
Pericardial
THORACIC AORTA
Superior phrenic
Diaphragm
Inferior phrenic
Left gastric
Celiac trunk
Inferior phrenic
Common hepatic
Left adrenal (su
Suprarenal
Right adrenal (suprarenal)
Splenic
Superior mesenteric
Right renal
Left renal
Right gonadal
Left gonadal
ABDOMINAL AORTA
Lumbar
Inferior mesenteric
Left common iliac
Median sacral
Left internal iliac (hypogastric)
Left external iliac
(b) Detailed anterior view
5th thoracic vertebra
Thoracic aorta
Diaphragm
Descending aorta
Abdominal aorta
4th lumbar vertebra

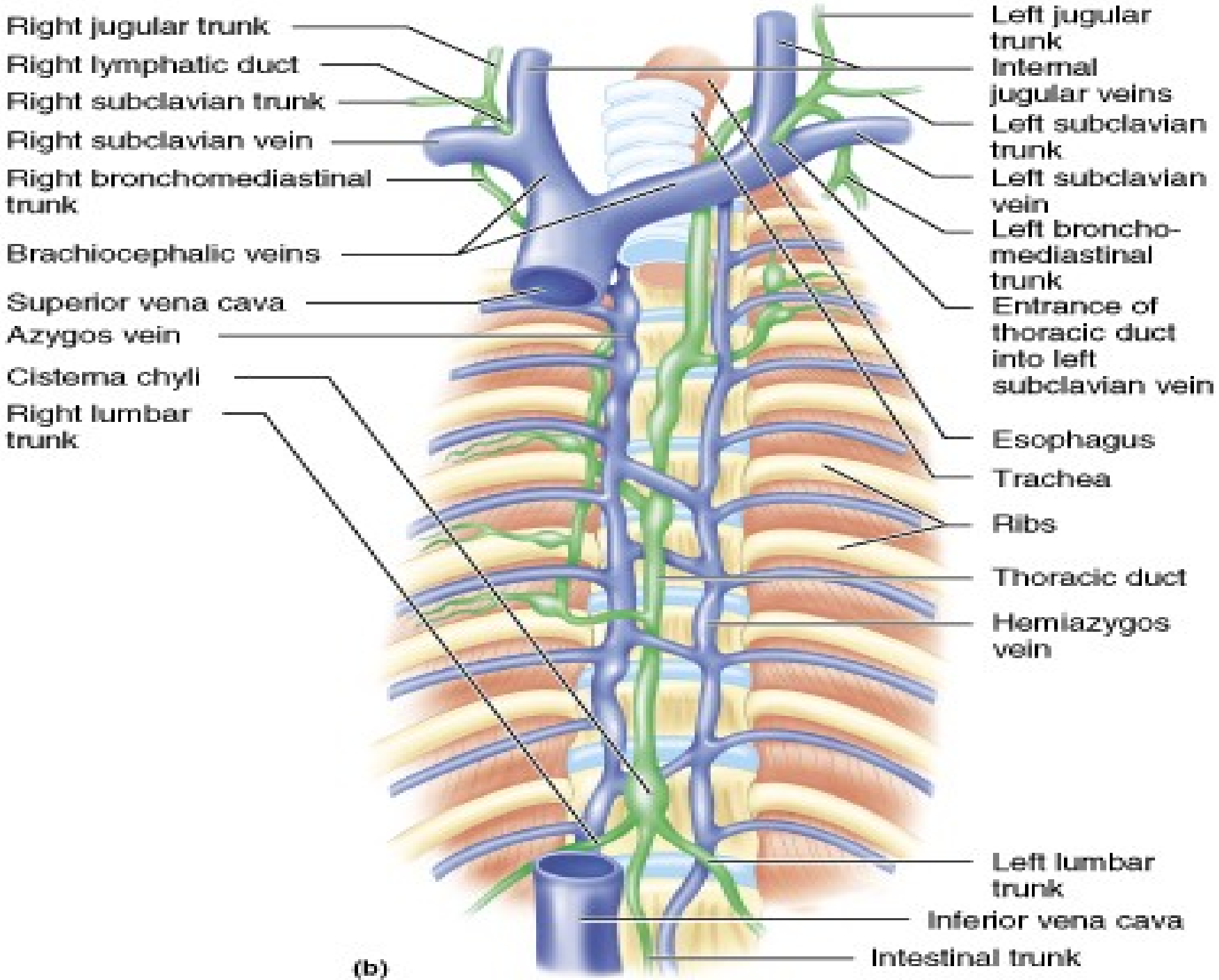

Common carotids
Vertebral
Thyrocervical
Left subclavian
Internal thoracic
Axillary
Bronchials
Pericardials
Mediastinals
THORACIC AORTA
Intercostals
Superior phrenic
Inferior phrenic
Celiac
Diaphragm
Left gastric
Splenic
Common hepatic
Suprarenal
Superior mesenteric
Renal
Gonadal
ABDOMINAL AORTA
Lumber
Right common iliac
Inferior mesenteric
External iliac
Terminal segment of the aorta
Internal iliac

SUPERFICIAL VEINS


Vertebral
Internal jugular
External jugular
Subclavian
Brachiocephalic
Highest intercostal
Axillary
Cephalic
Hemiazygos
Brachial
Intercostals
Basilic
Phrenics
Suprarenals
Median cubit
Cephalic
Radial
Median
Basilic
Ulnar
Palmar venous arches
Superior vena cava
Esophageal
Mediastinals
Azygos
Internal thoracic
Inferior vena cava
Hepatics
Renals
Gonadals
Lumbars
Common iliac
Internal iliac
External iliac

LYMPHATICS

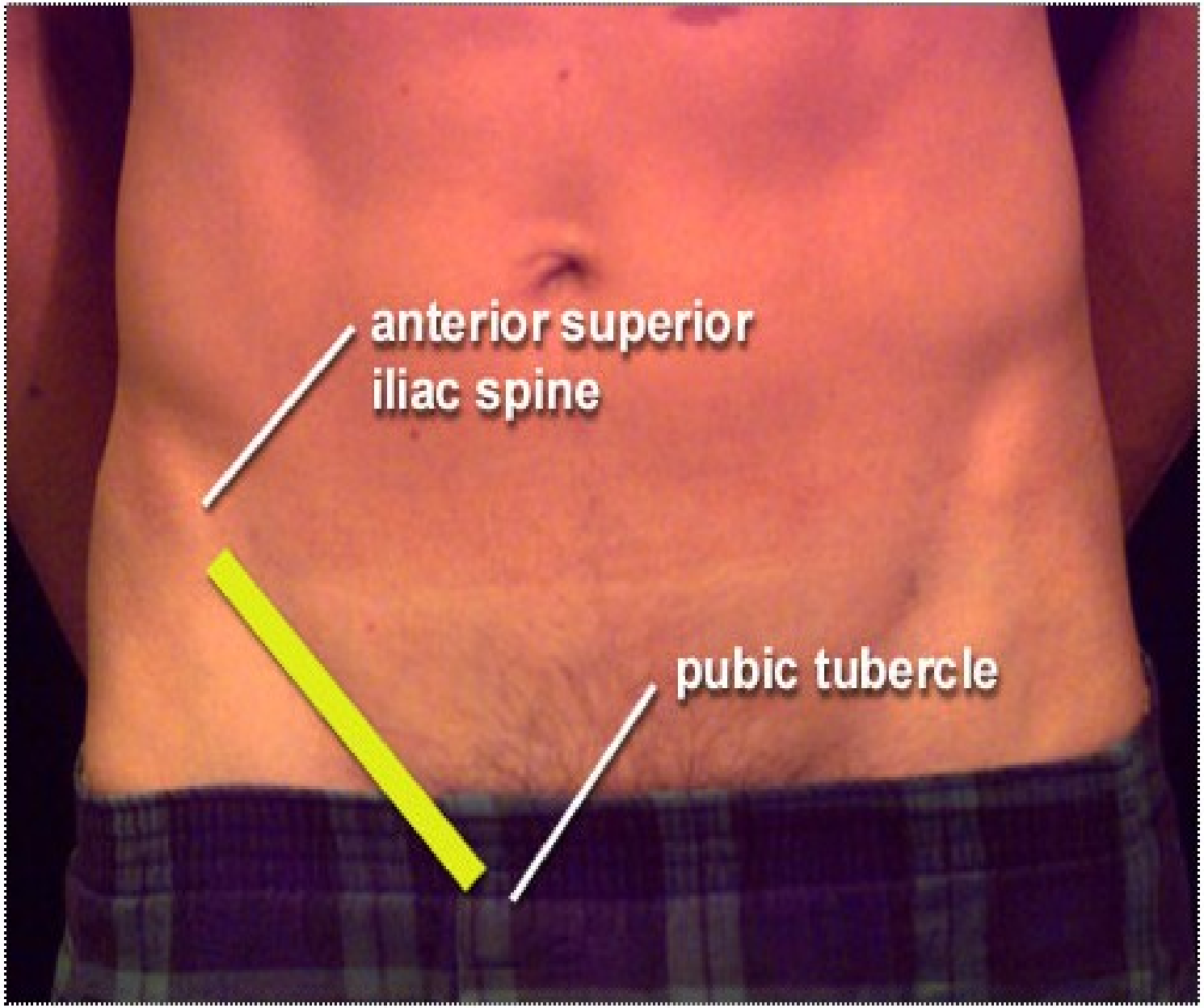

Regional lymph nodes:
Entrance of right lymphatic duct into right subclavian vein
Cervical nodes
Internal jugular vein
Entrance of thoracic duct into left subclavian vein
Axillary nodes
Thoracic duct
Aorta
Cisterna chyli
Lymphatic collecting vessels
Inguinal nodes


Right jugular trunk
Right lymphatic duct
Right subclavian trunk
Right subclavian vein
Right bronchomediastinal trunk
Brachiocephalic veins
Superior vena cava
Azygos vein
Cisterna chyli
Right lumbar trunk
Left jugular trunk
Internal jugular veins
Left subclavian trunk
Left subclavian vein
Left broncho-mediastinal trunk
Entrance of thoracic duct into left subclavian vein
Esophagus
Trachea
Ribs
Thoracic duct
Hemiazygos vein
Left lumbar trunk
Inferior vena cava
Intestinal trunk
(b)

INGUINAL REGION

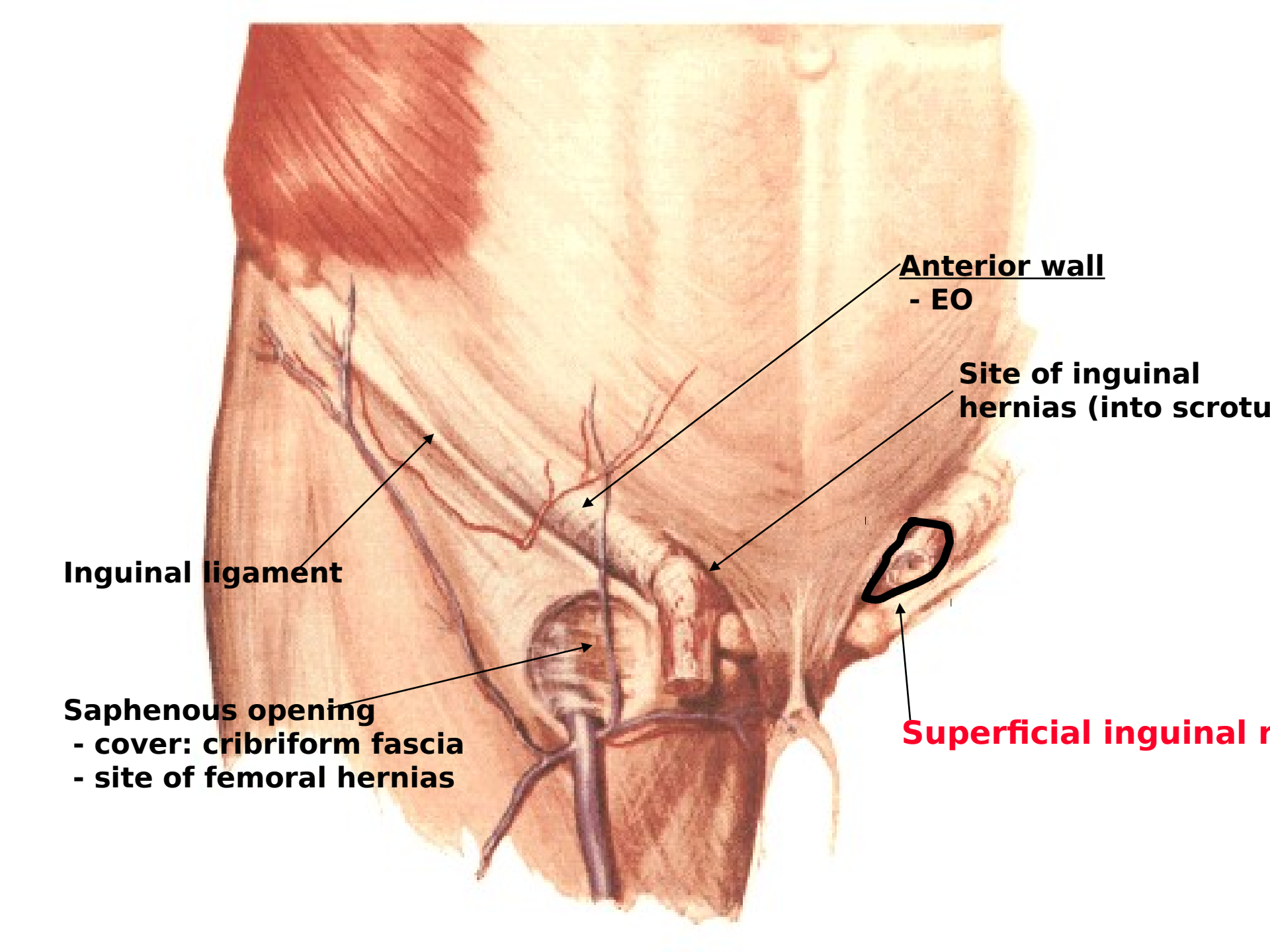
- Important surgically because it is the site of *inguinal hernias* (“ruptures”), that is protrusion of a structures, viscus, or organ (Moore, p.147-9)
- An area of weakness in the anterior abdominal wall, especially in men due to the prenatal penetration of the wall by the testis & spermatic cord.

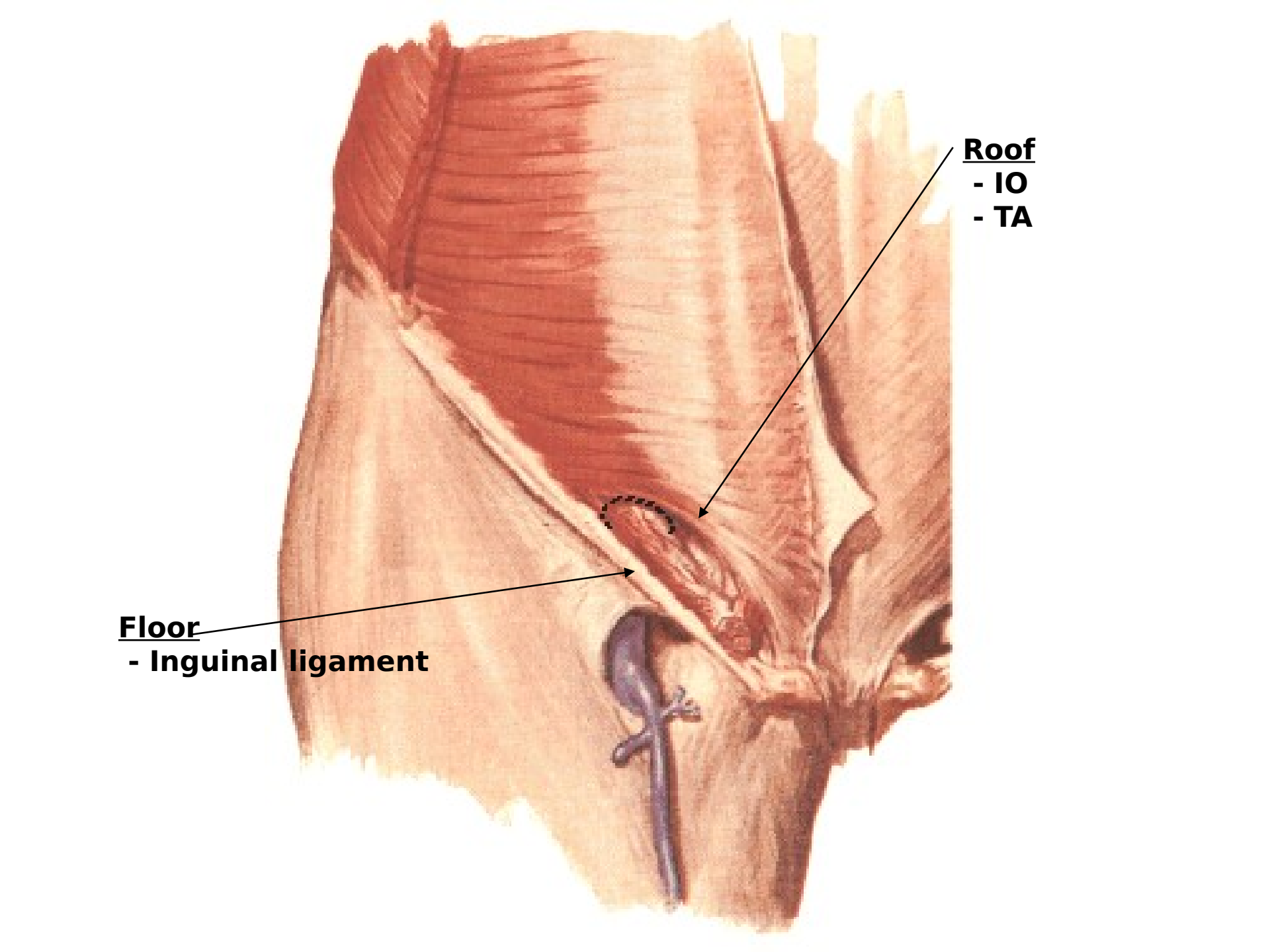
Surface Anatomy: Inguinal Ligament

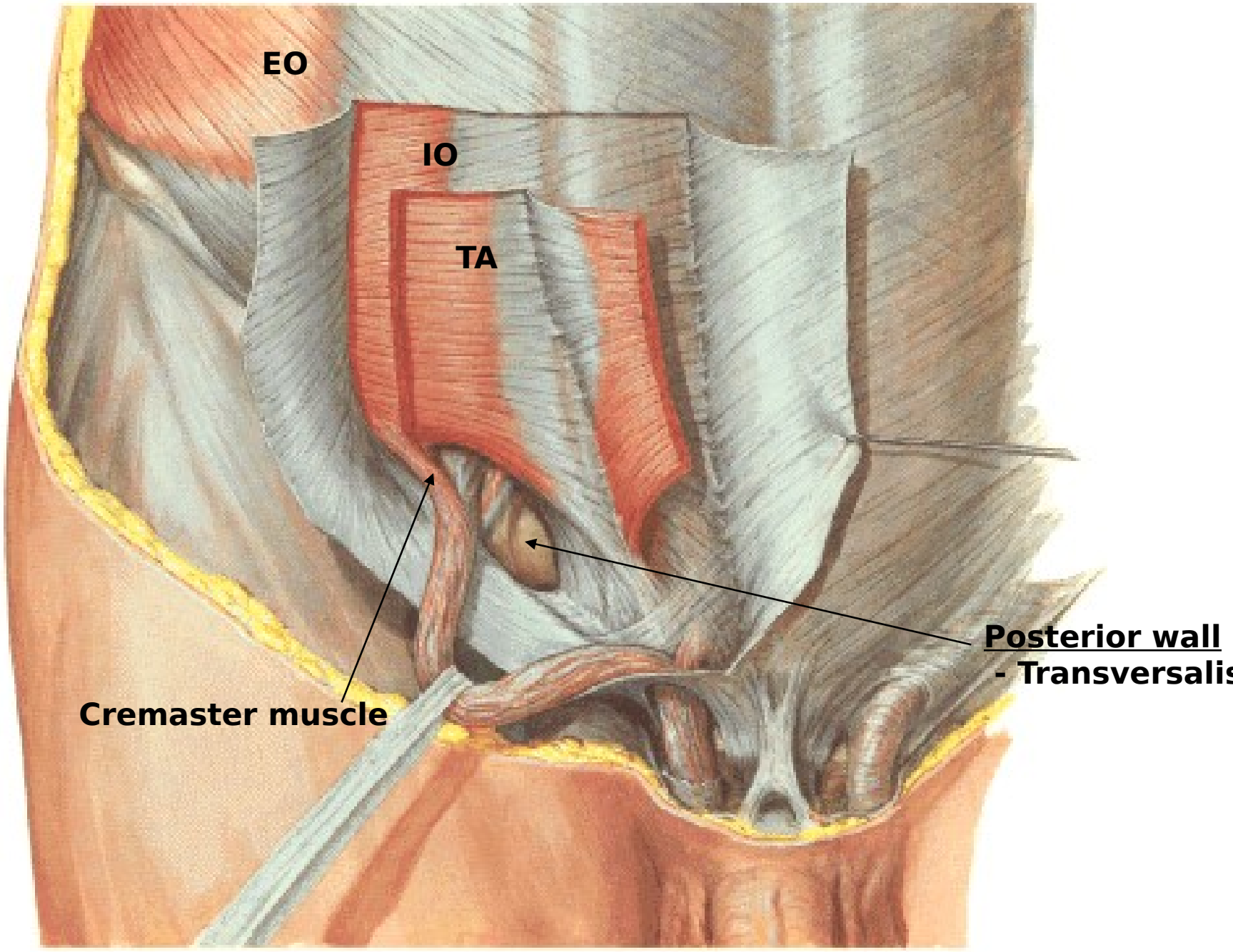


INGUINAL CANAL

- Deep ring (slit)
- Superficial ring - a deficiency in the aponeurosis of EO
- Roof: IO, TA
- Anterior wall: EO
- Floor: Inguinal/lacunar ligaments
- Posterior wall: Transversalis fascia and conjoint tendon

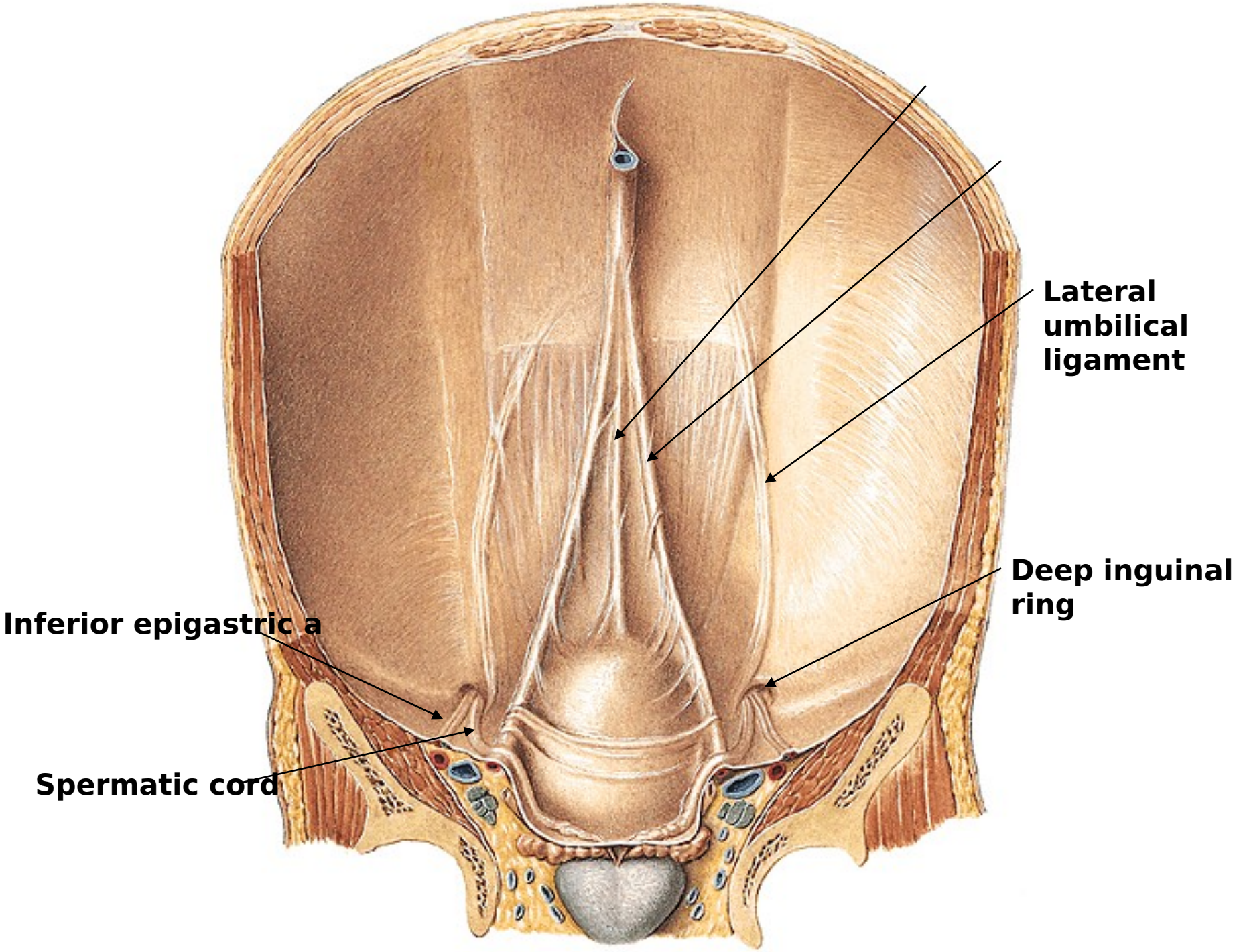

Anterior wall
- EO
Site of inguinal
hernias (into scrotu
Inguinal ligament
Saphenous opening
- cover: cribriform fascia
- site of femoral hernias
Superficial inguinal r

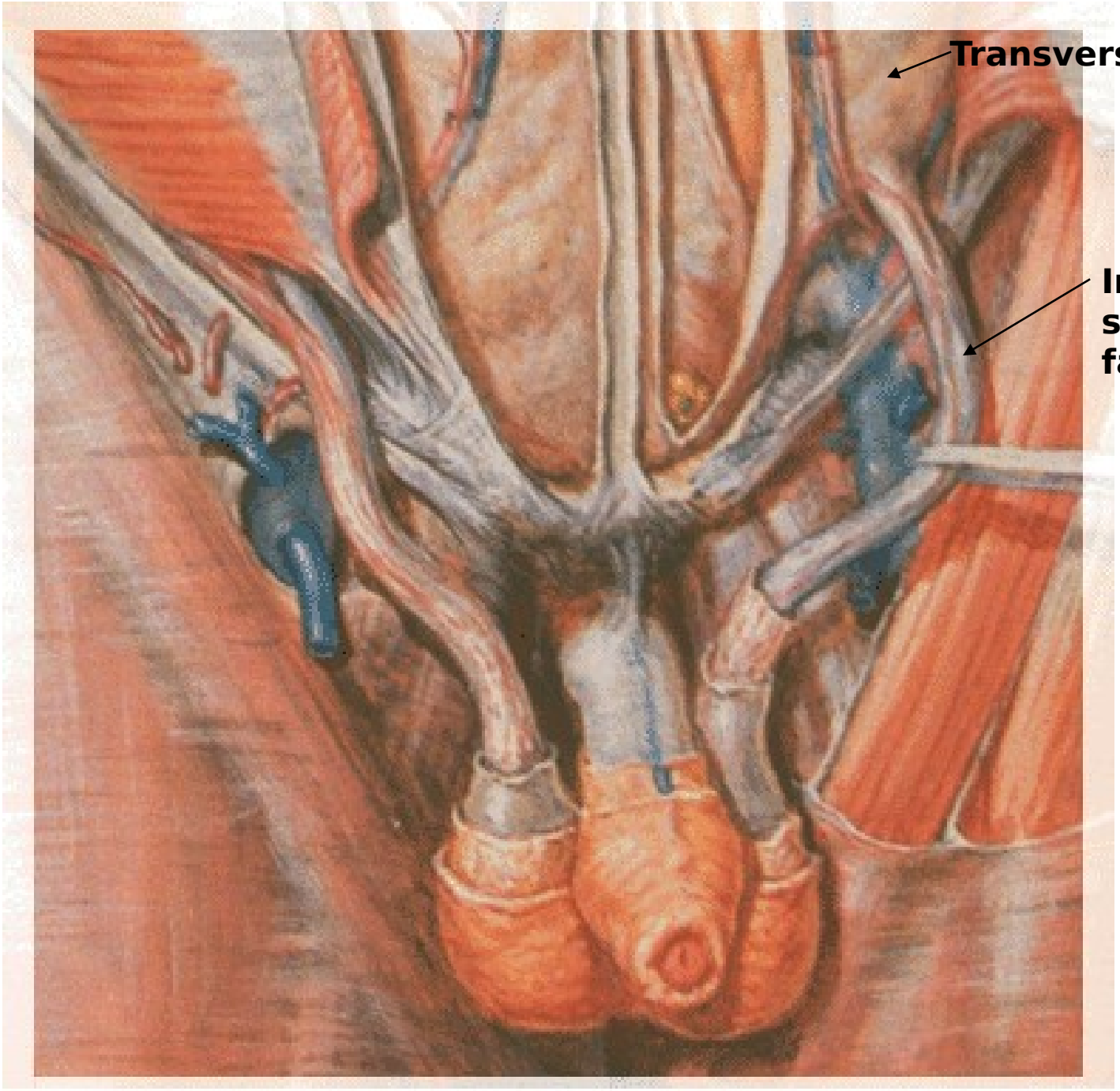

Roof
- IO
- TA
Floor
- Inguinal ligament


EO
IO
TA
Cremaster muscle
Posterior wall
- Transversalis

INGUINAL HERNIAS

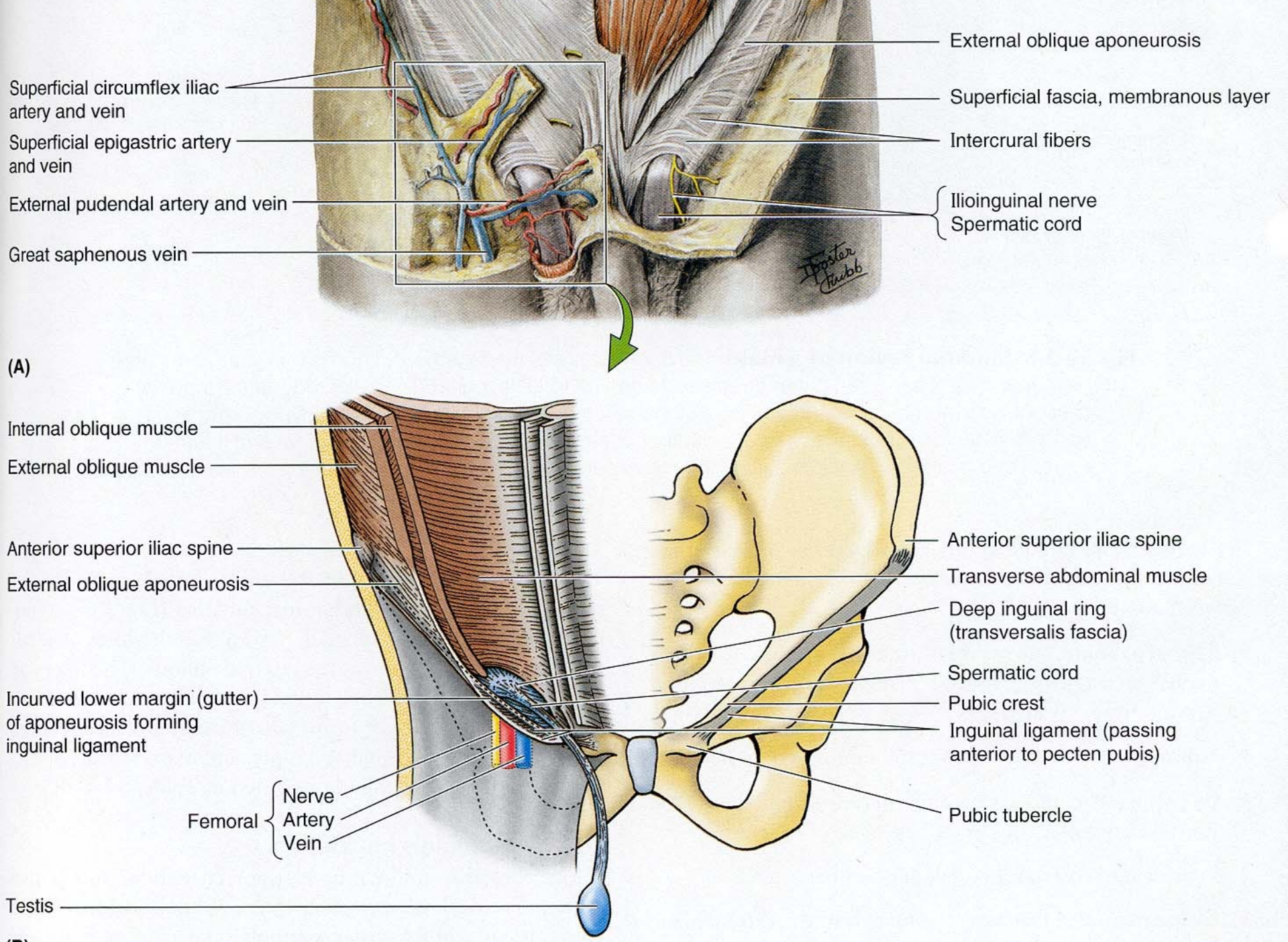
- Indirect inguinal hernias
  - Deep inguinal ring
  - Inguinal canal
  - Superficial inguinal ring
    - Into scrotum within Spermatic Cord
- Direct inguinal hernias
  - Posterior wall of inguinal canal
  - Superficial inguinal ring
    - Into scrotum outside Spermatic Cord


Lateral umbilical ligament
Deep inguinal ring
Inferior epigastric a
Spermatic cord


Transversalis fascia
Internal spermatic fascia

INGUINAL HERNIAS

- Indirect inguinal hernia
  - Lateral to inferior epigastric a
- Direct inguinal hernia
  - Medial to inferior epigastric a


External oblique aponeurosis
Superficial circumflex iliac artery and vein
Superficial fascia, membranous layer
Superficial epigastric artery and vein
Intercrural fibers
External pudendal artery and vein
Ilioinguinal nerve
Spermatic cord
Great saphenous vein
(A)
Internal oblique muscle
External oblique muscle
Anterior superior iliac spine
Anterior superior iliac spine
External oblique aponeurosis
Transverse abdominal muscle
Deep inguinal ring (transversalis fascia)
Spermatic cord
Incurved lower margin (gutter) of aponeurosis forming inguinal ligament
Pubic crest
Inguinal ligament (passing anterior to pecten pubis)
Femoral
Nerve
Artery
Vein
Pubic tubercle
Testis
(B)

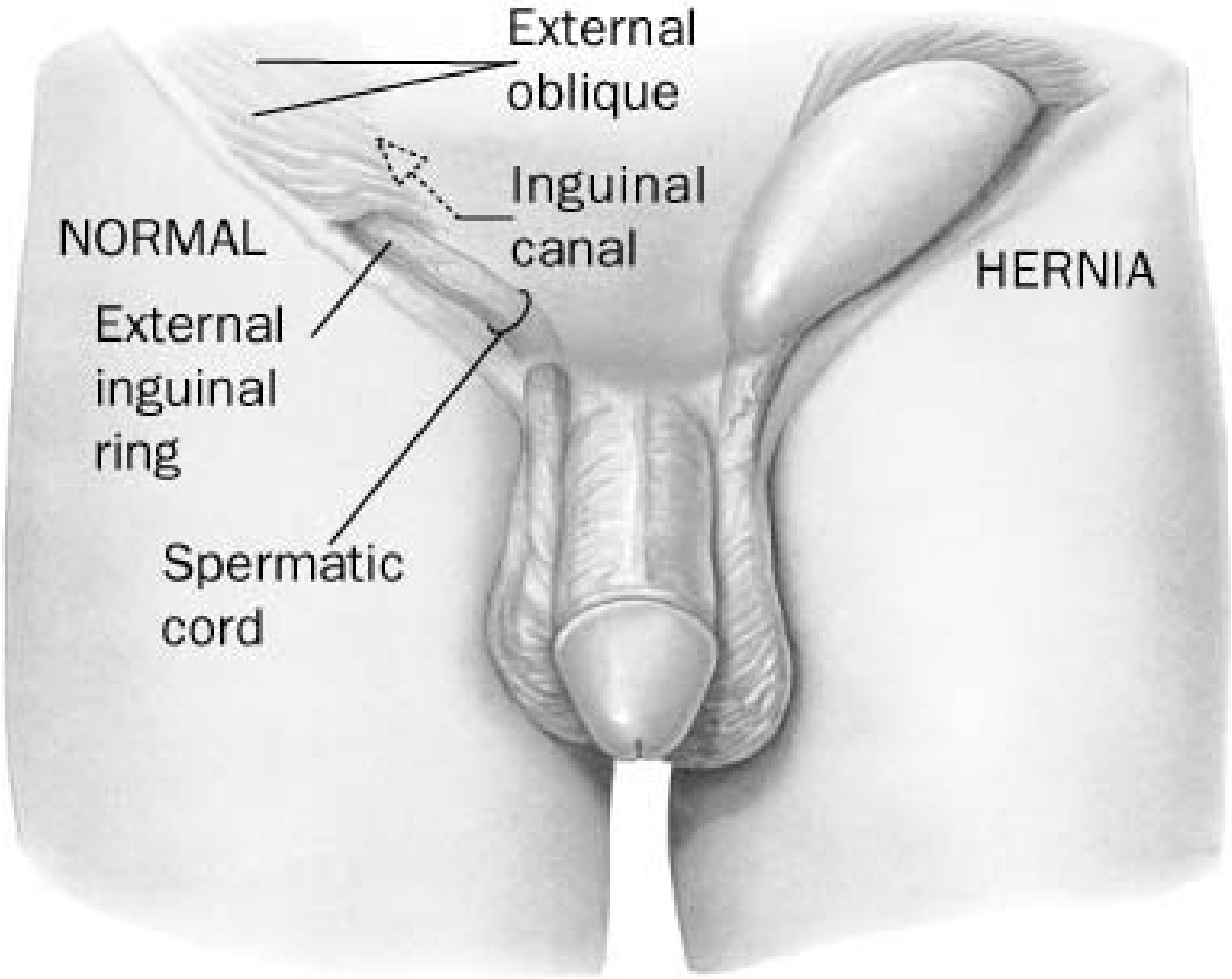
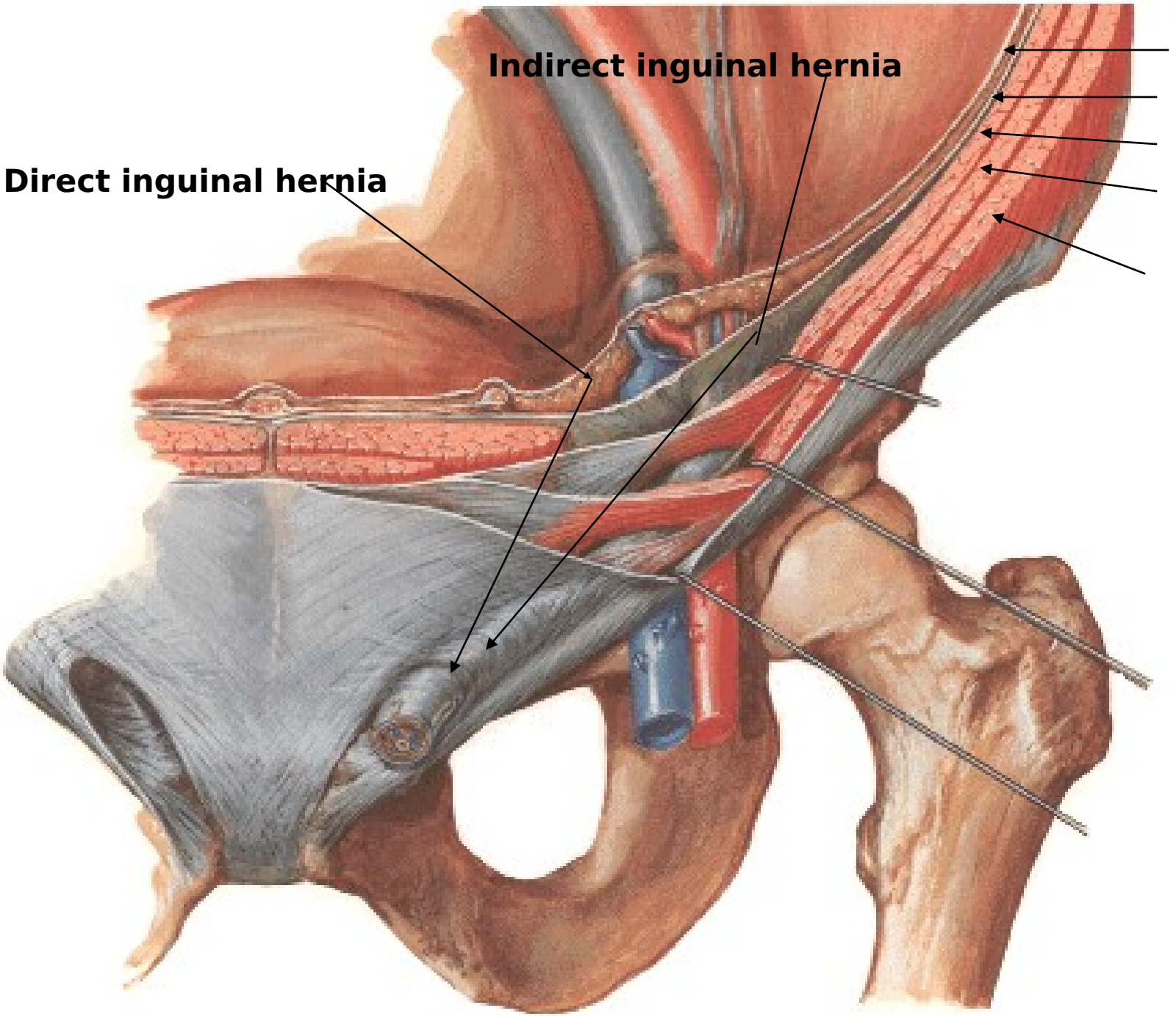
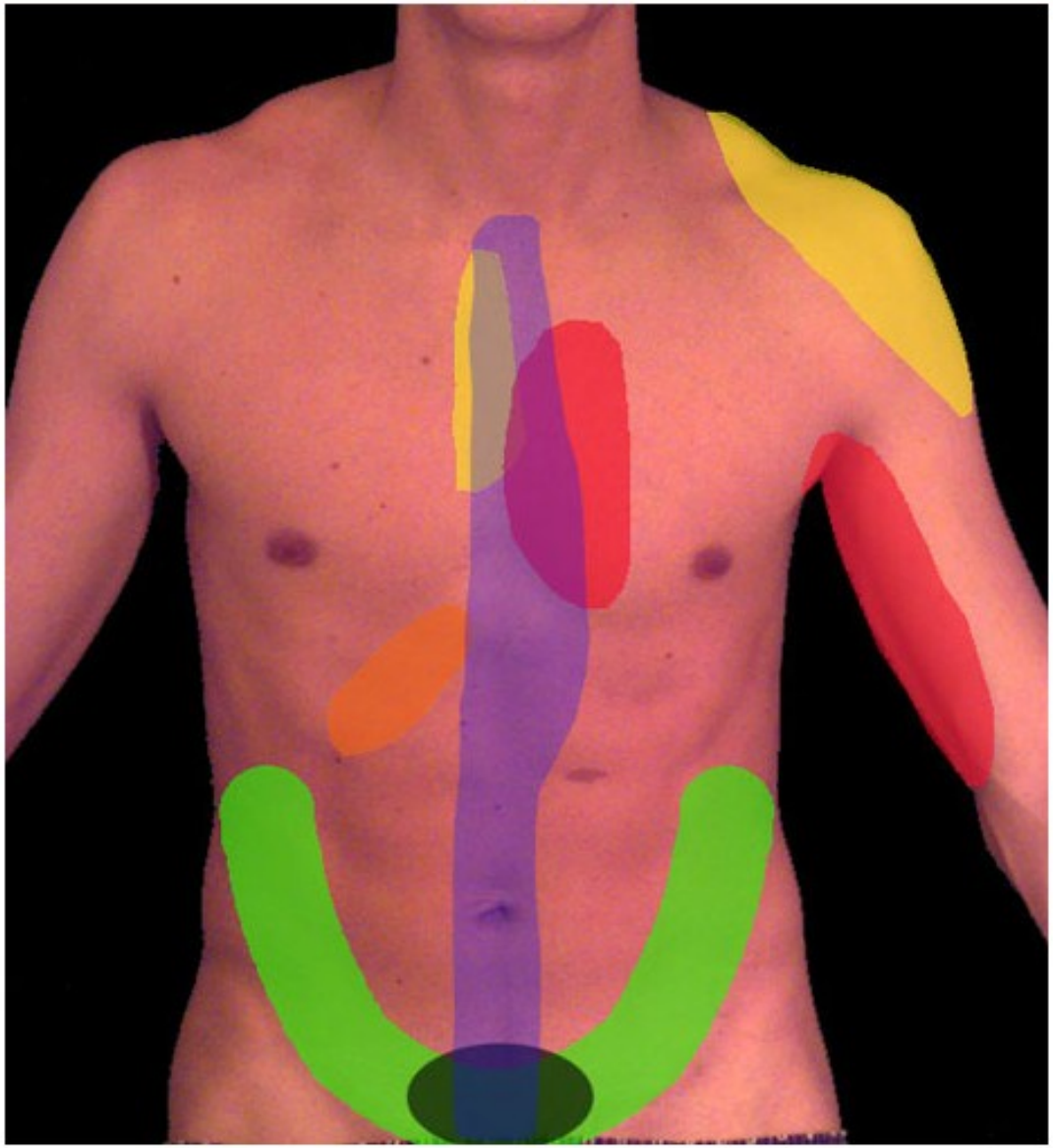


Figure A-24 Inguinal Hernia


Indirect inguinal hernia
Direct inguinal hernia

Surface Anatomy: Referred Pain



Diaphragm, Pericardium and Heart, Heart, Digestive tract, Liver and Gall Bladder, Kidney and Ureter, Pelvic Organs

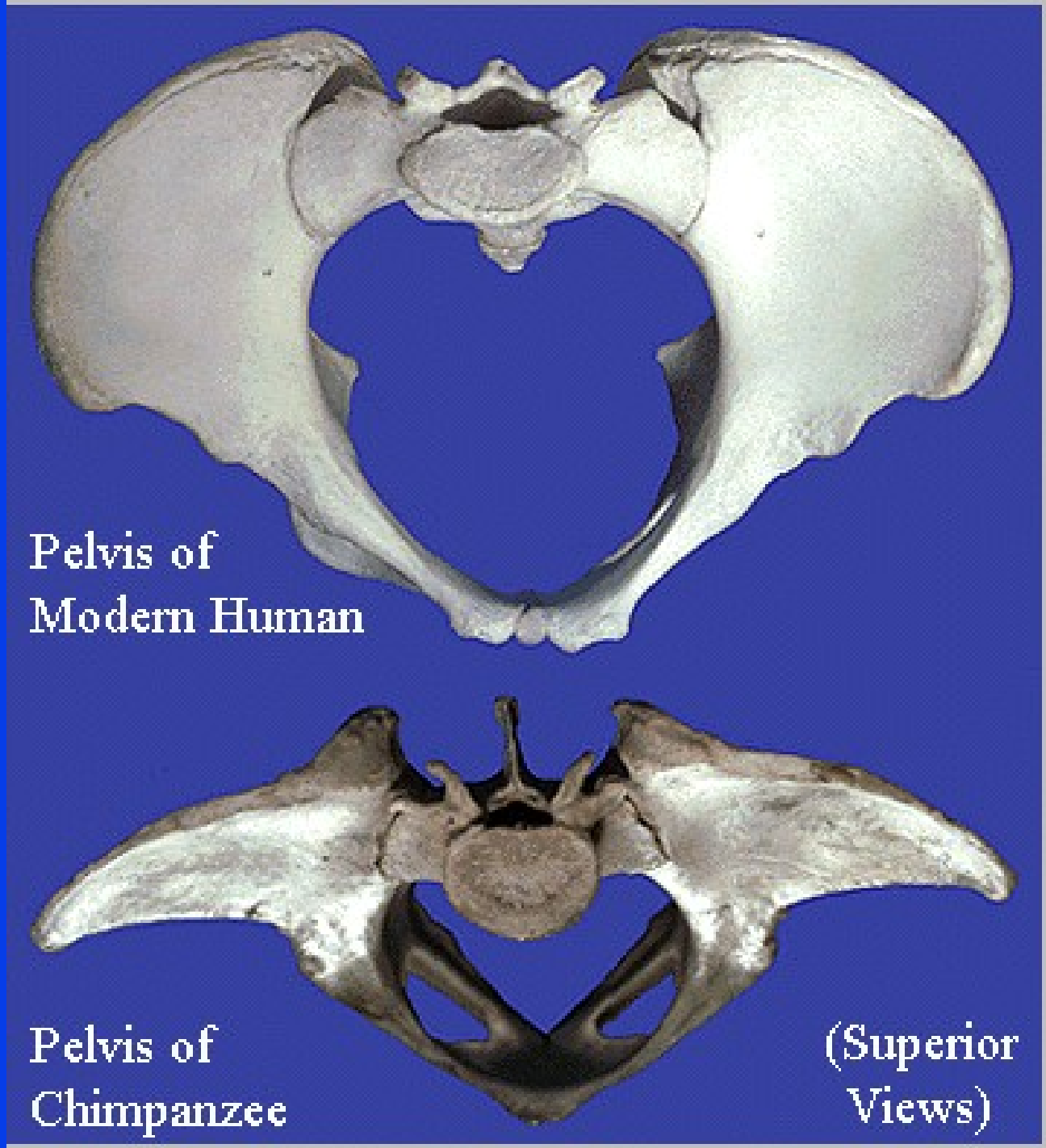
QUESTIONS?

Positional Behavior - the entire repertoire of positions that an animal engages in, including movement or **locomotion**:

E.g.: leaping, quadrupedalism (arboreal and/or terrestrial), suspensory behavior (climbing, bridging, brachiation), bipedalism;

and positions at rest or **posture**:

E.g.: sitting, standing, hanging, feeding, sleeping, clinging.

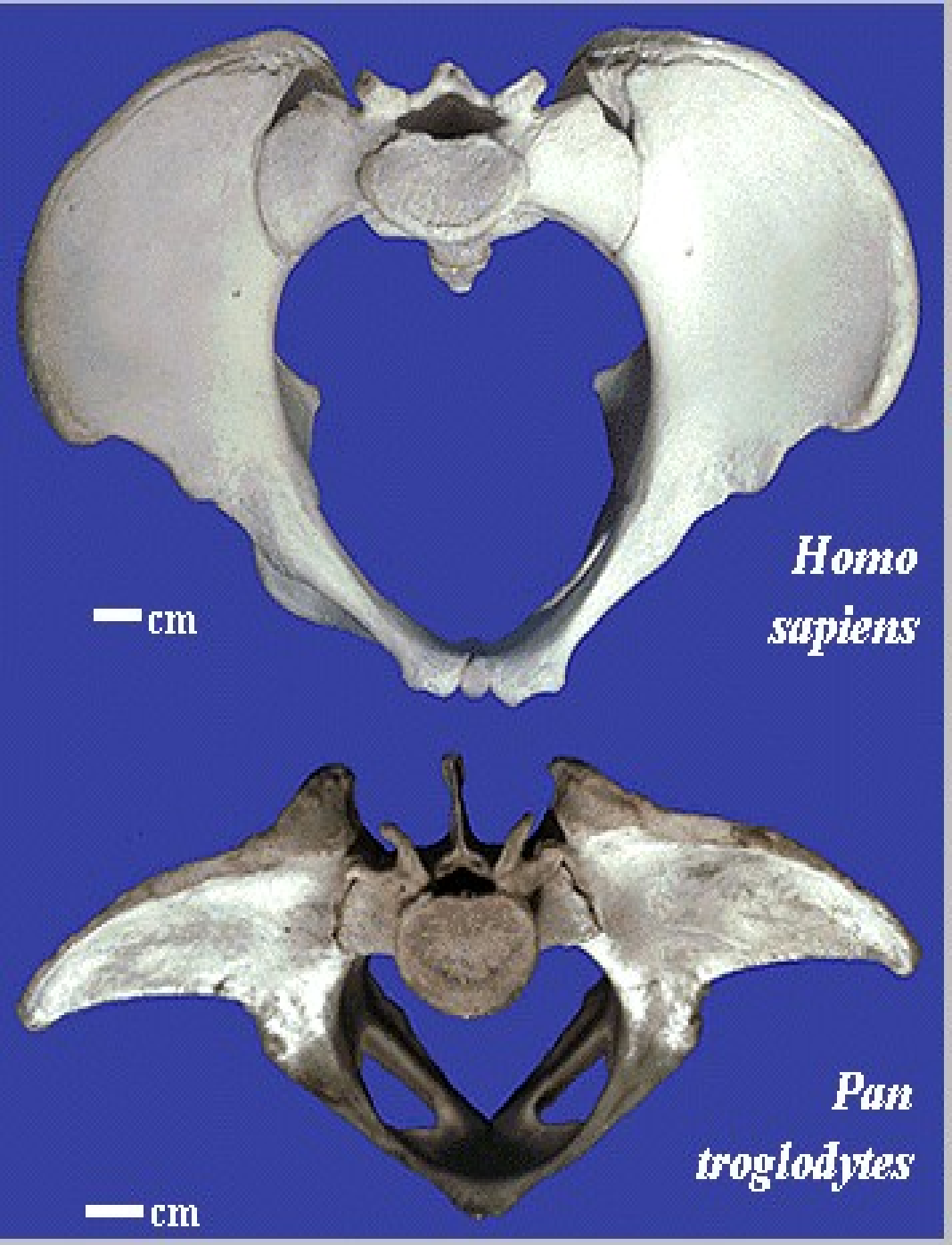

Pelvis of
Modern Human
Pelvis of
Chimpanzee
(Superior
Views)

Introduction

This lab focuses on the postcranial anatomy of the australopithecines and the anatomical adaptations that facilitate bipedal locomotion. Although many animals practice facultative bipedalism, habitual bipedalism is rare. The evolution of this locomotor behavior is one of the key characteristics that distinguishes hominids from the other primates. Be sure to watch the movie.

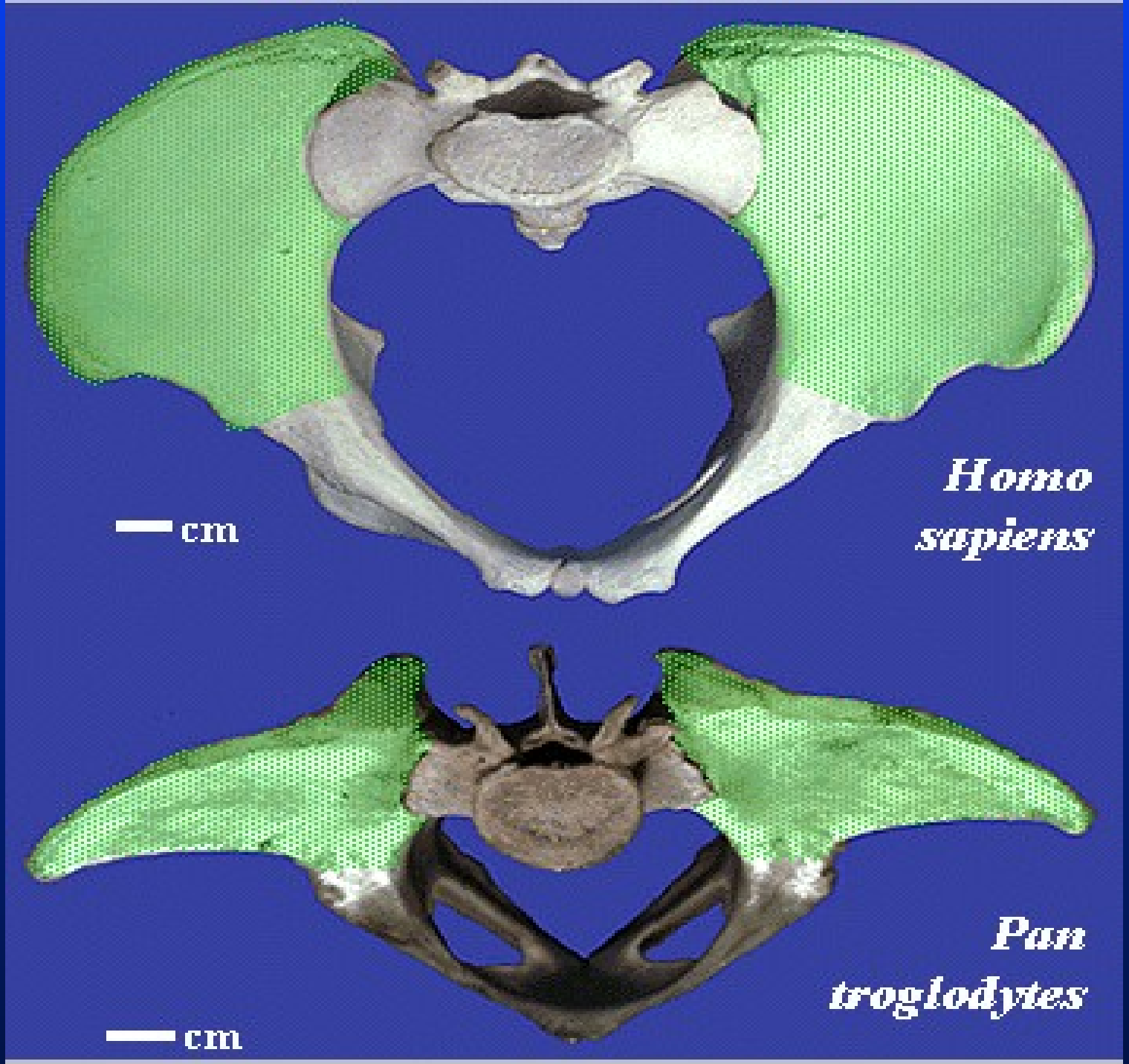
The lower back, pelvis, and lower extremities demonstrate the most obvious adaptations for bipedalism. This virtual laboratory investigates these aspects of the postcranial morphology of early hominids. Remember that these anatomical adaptations have evolved over millions of years and that differences exist between earlier and later species.

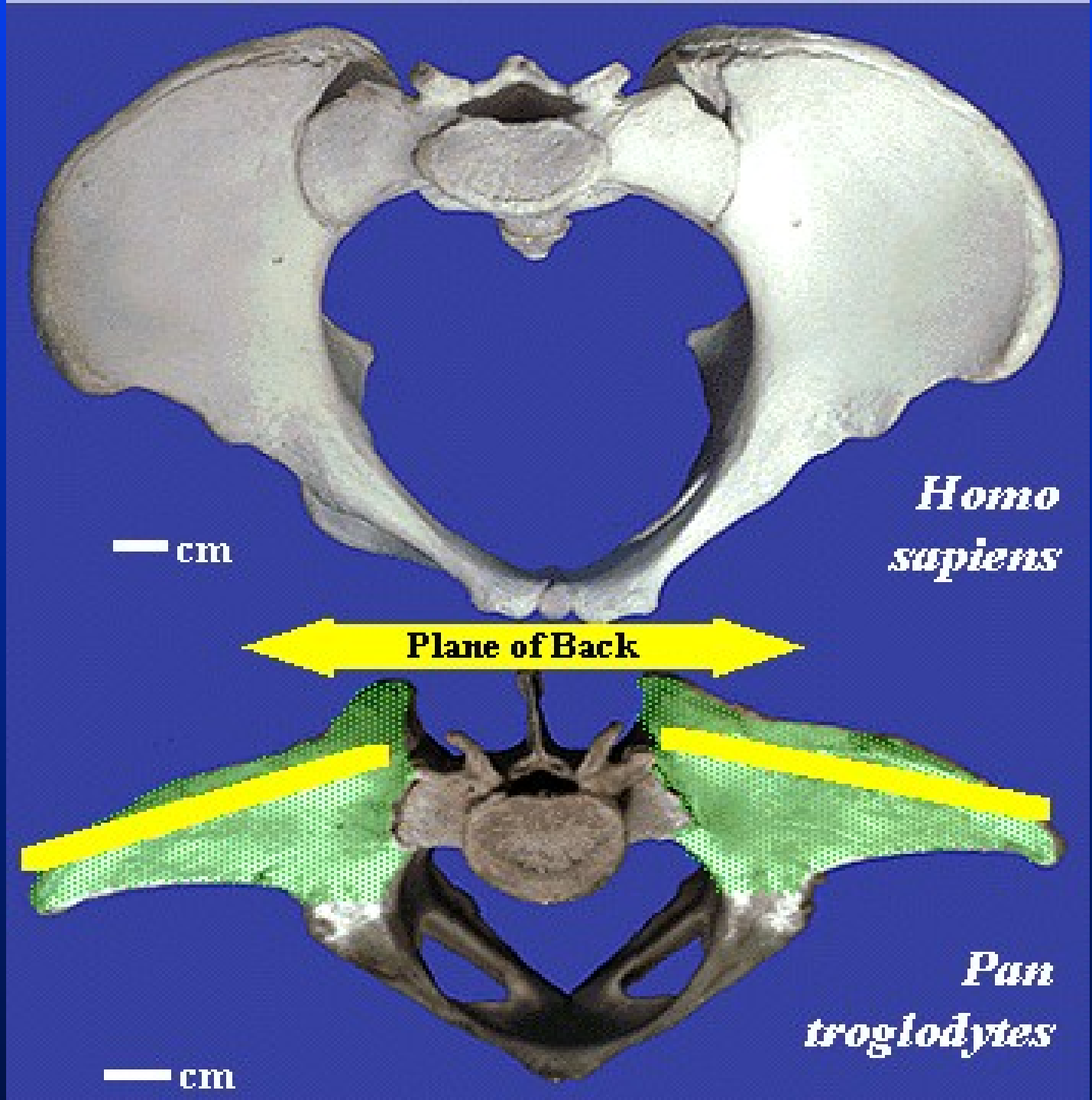
The partial skeleton of Lucy, a 3.2 million year old specimen of *Australopithecus afarensis*

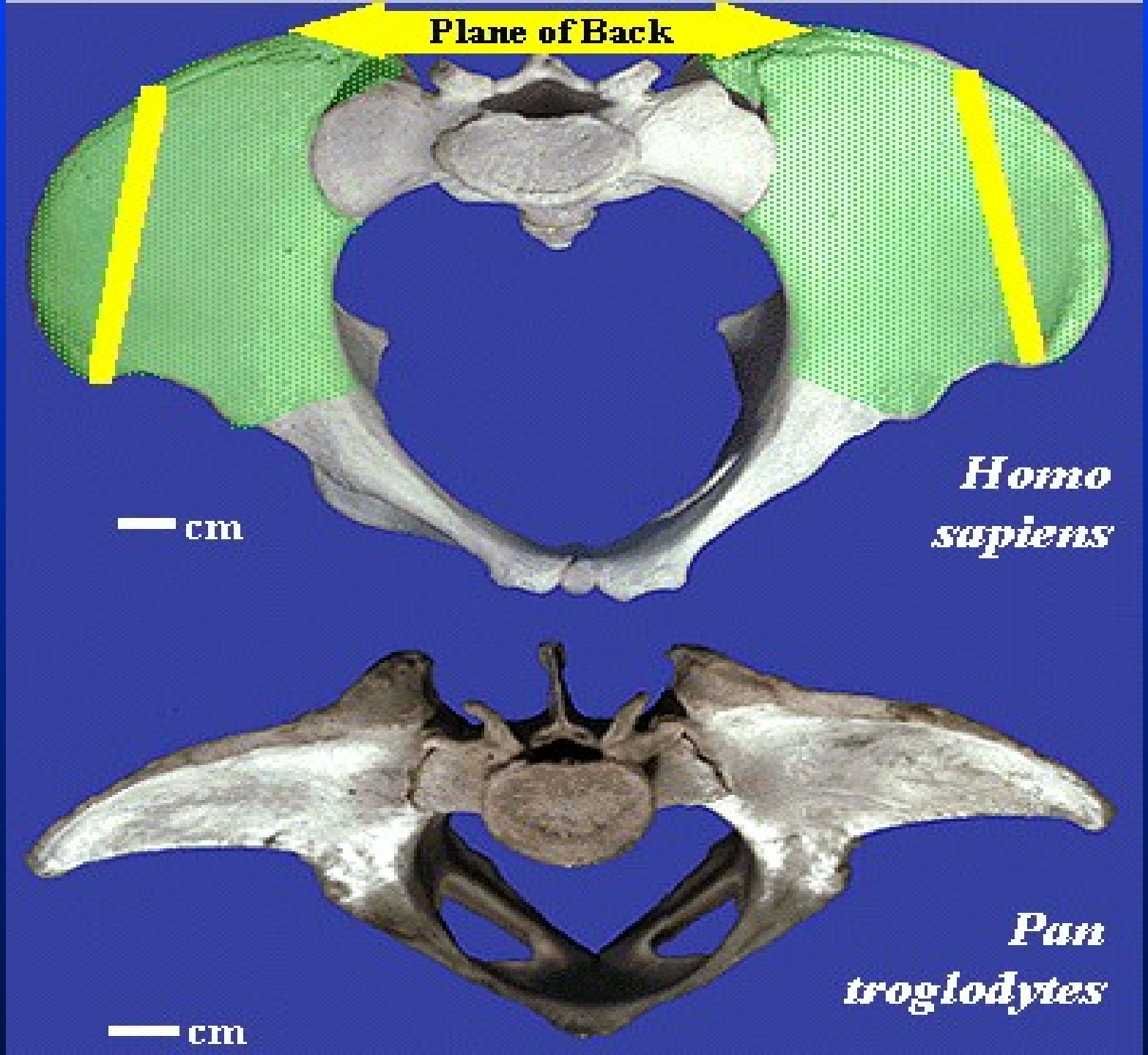


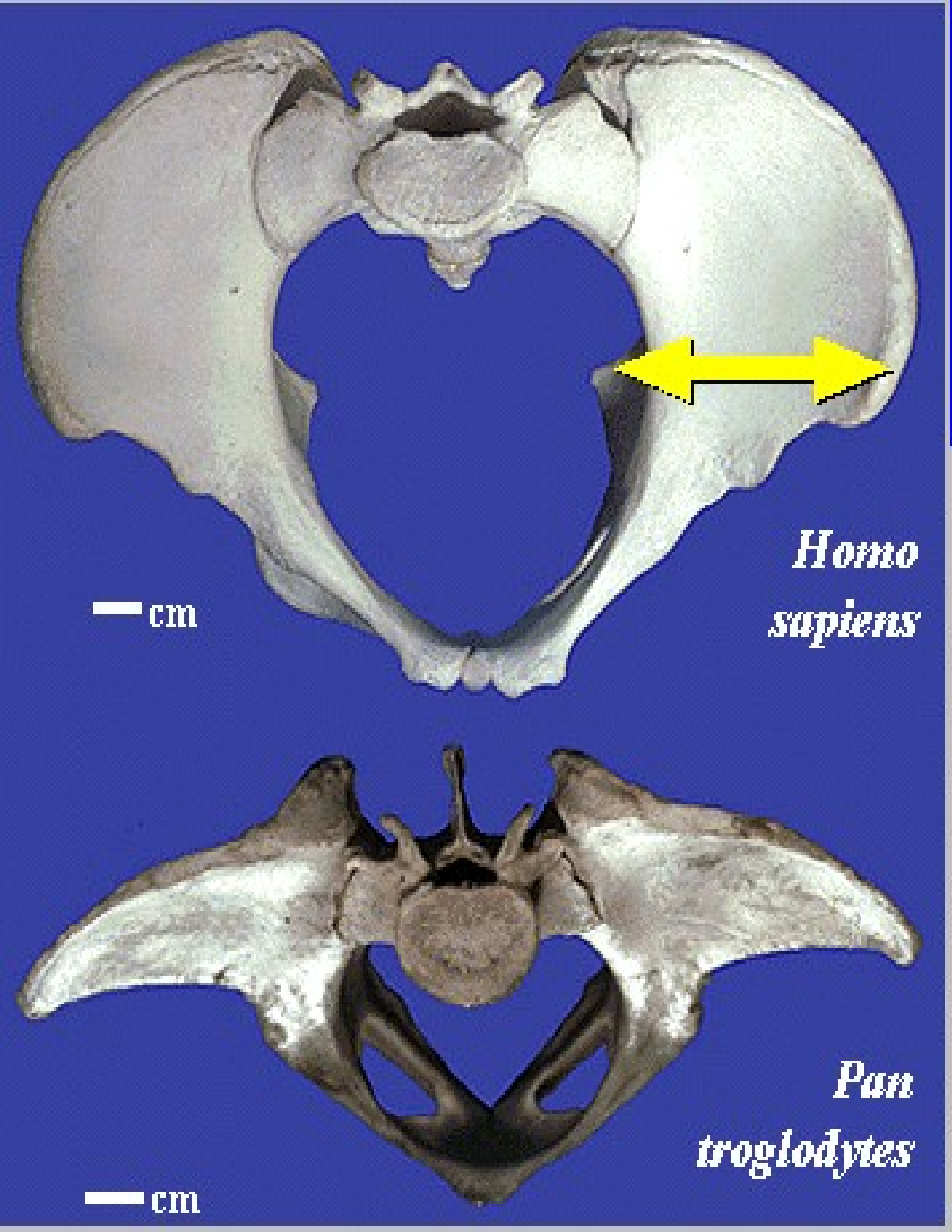
The orientation of the iliac ala differs in humans and in apes. (The anatomical term ala means "winglike structure.") In apes, the flat portion of the iliac ala is roughly parallel with the plane of the back, while in humans it is shifted laterally and positioned more to the side.

The orientation of the iliac blade affects the action of lesser gluteal muscles. In humans these are abductors of the hip and they prevent the hip on the supported side from collapsing toward the unsupported side, thus increasing stability during bipedal locomotion. In the apes, these muscles act as hip extensors and move the leg backward when a primate pushes forward to take a step and thus aid in propulsion.


cm
Homo sapiens
cm
Pan troglodytes

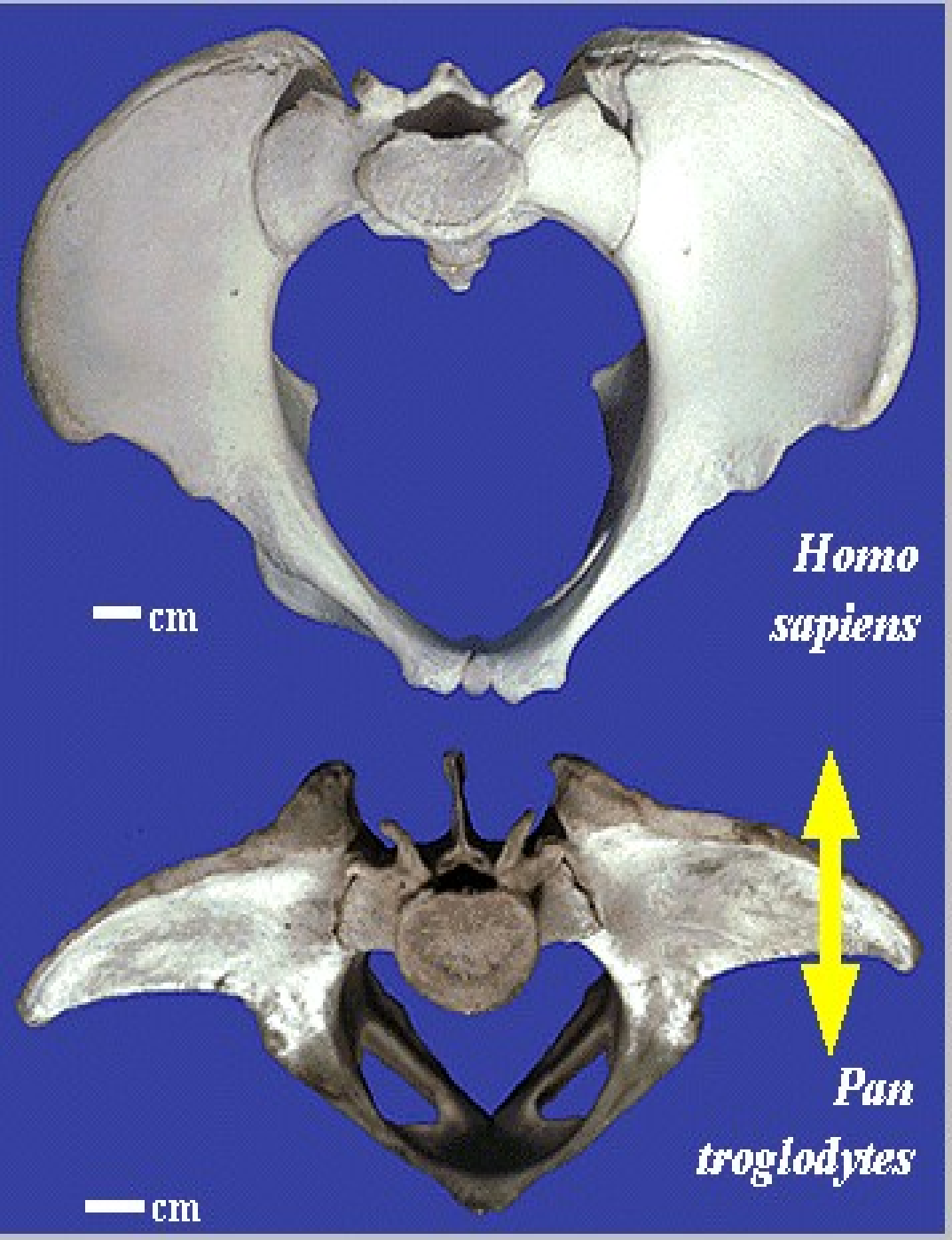

cm
Homo sapiens
Plane of Back
Pan troglodytes
cm


Plane of Back
cm
Homo sapiens
cm
Pan troglodytes



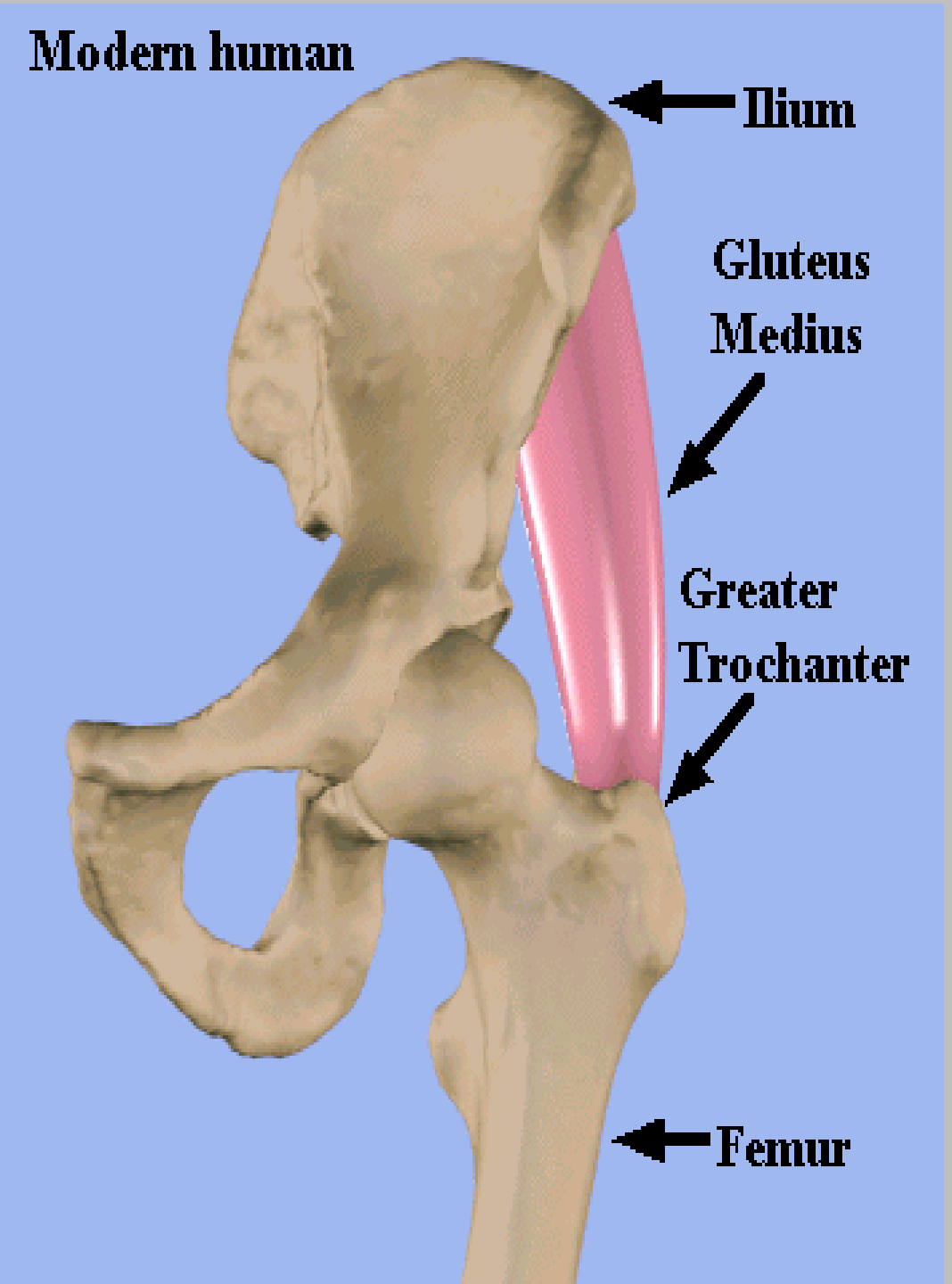
The arrow shows the approximate line of action of the small gluteal muscles (gluteus minimus and medius) when they contract and abduct the thigh. The gluteus medius is also a rotator of the thigh.

The orientation of the iliac blade affects the action of lesser gluteal muscles. In humans these are **abductors** of the hip and they prevent the hip on the supported side from collapsing toward the unsupported side, thus increasing stability during bipedal locomotion. In the apes, these muscles act as hip **extensors** and move the leg backward when a primate pushes forward to take a step and thus aid in propulsion.



The arrow shows the approximate line of action of the smaller gluteal muscles (gluteus minimus and medius) when they contract and extend the thigh in apes. Note again how the orientation of the iliac ala controls the action of these muscles.

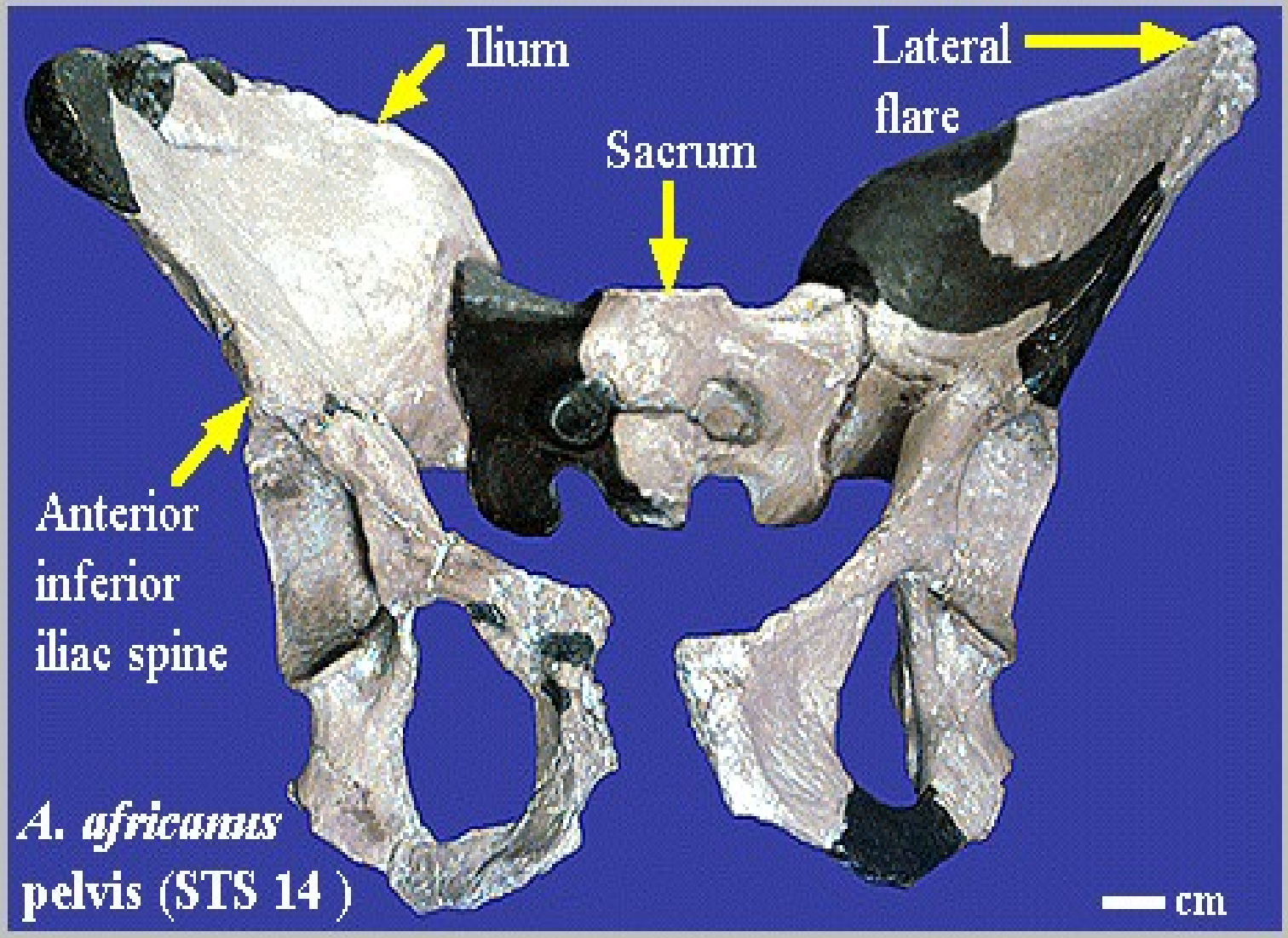
The orientation of the iliac blade affects the action of lesser gluteal muscles. In humans these are **abductors** of the hip and they prevent the hip on the supported side from collapsing toward the unsupported side, thus increasing stability during bipedal locomotion. In the apes, these muscles act as hip **extensors** and move the leg backward when a primate pushes forward to take a step and thus aid in propulsion.



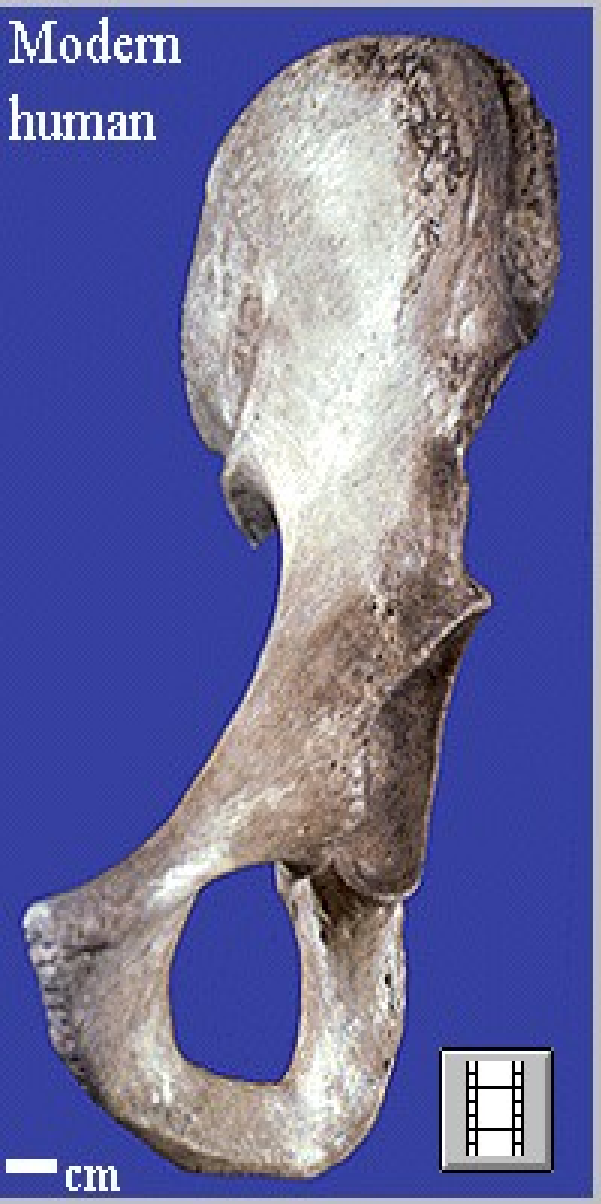
Abduction

Here is a 3-D reconstruction showing the attachment of the gluteus medius muscle that you just studied on the previous screen. It originates on the dorsal (back) side of the ilium and inserts on the greater trochanter of the femur, as does the gluteus minimus (not shown).

Remember that the iliac ala has more of a lateral orientation in humans as compared to a more posterior orientation in the apes. As a consequence, in humans these muscles abduct the femur at the hip joint.



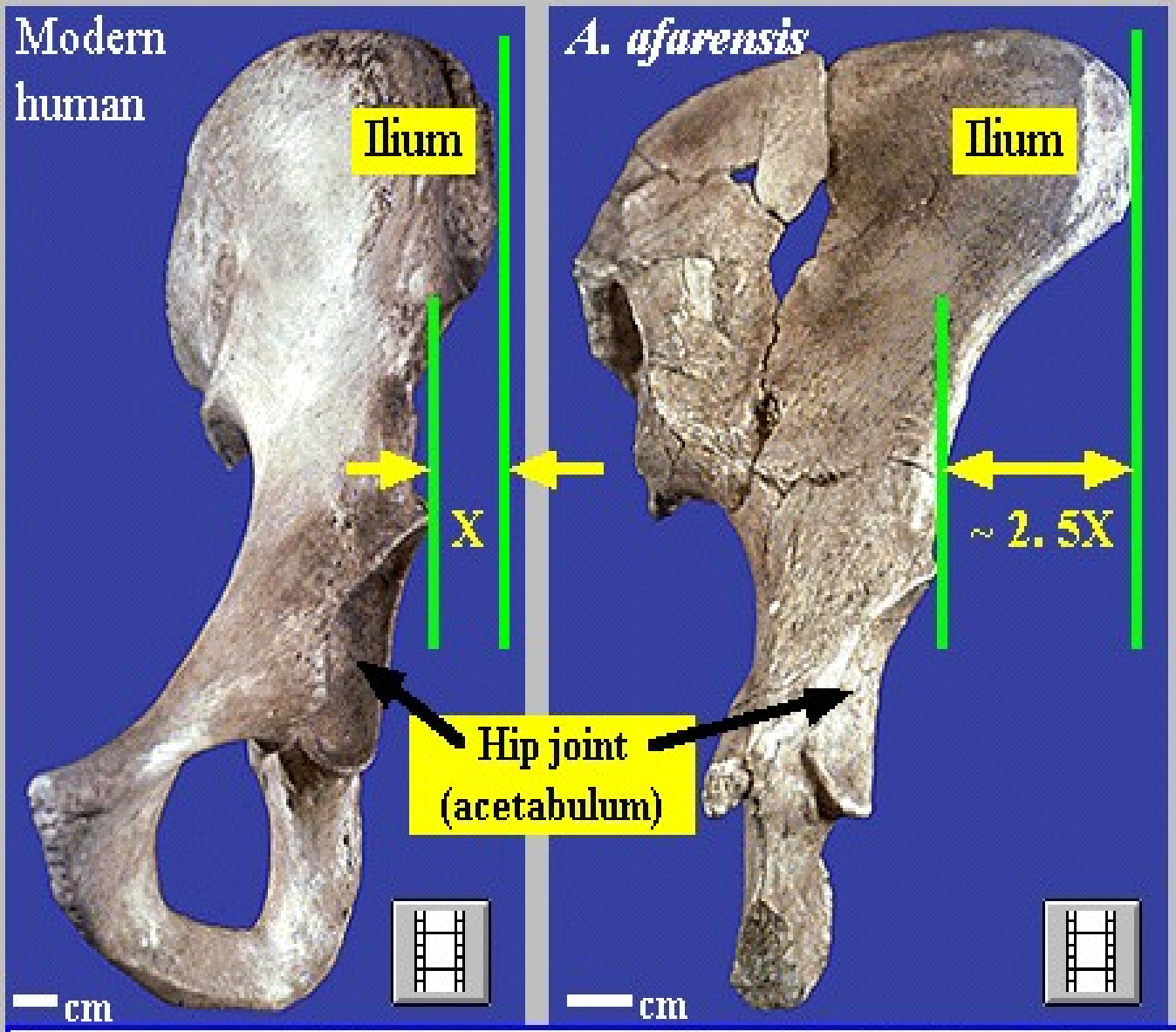
Here is an australopithecine pelvis. (Areas shown in black are reconstructed.) Note the short, well-developed anterior inferior iliac spine, widely flaring iliac ala, and the wide sacrum, all hallmarks of bipedal locomotion. There is a more pronounced lateral flare in the ilia than is present in modern humans.



Anterior views of modern human (left) and australopithecine, *A. afarensis* (right: AL 288-1ao) os coxae or left pelvic bone.

Although the exact function of its smaller gluteals is unknown, it is clearly the case that *Australopithecus* has an ala of the ilium that flares more laterally (to the side) than in *Homo*. This flare is a critical component of the lever system of the hip and acts to increase the mechanical advantage of the lesser gluteals by increasing their lever arm.

Be sure to view the animations to clearly see this difference.

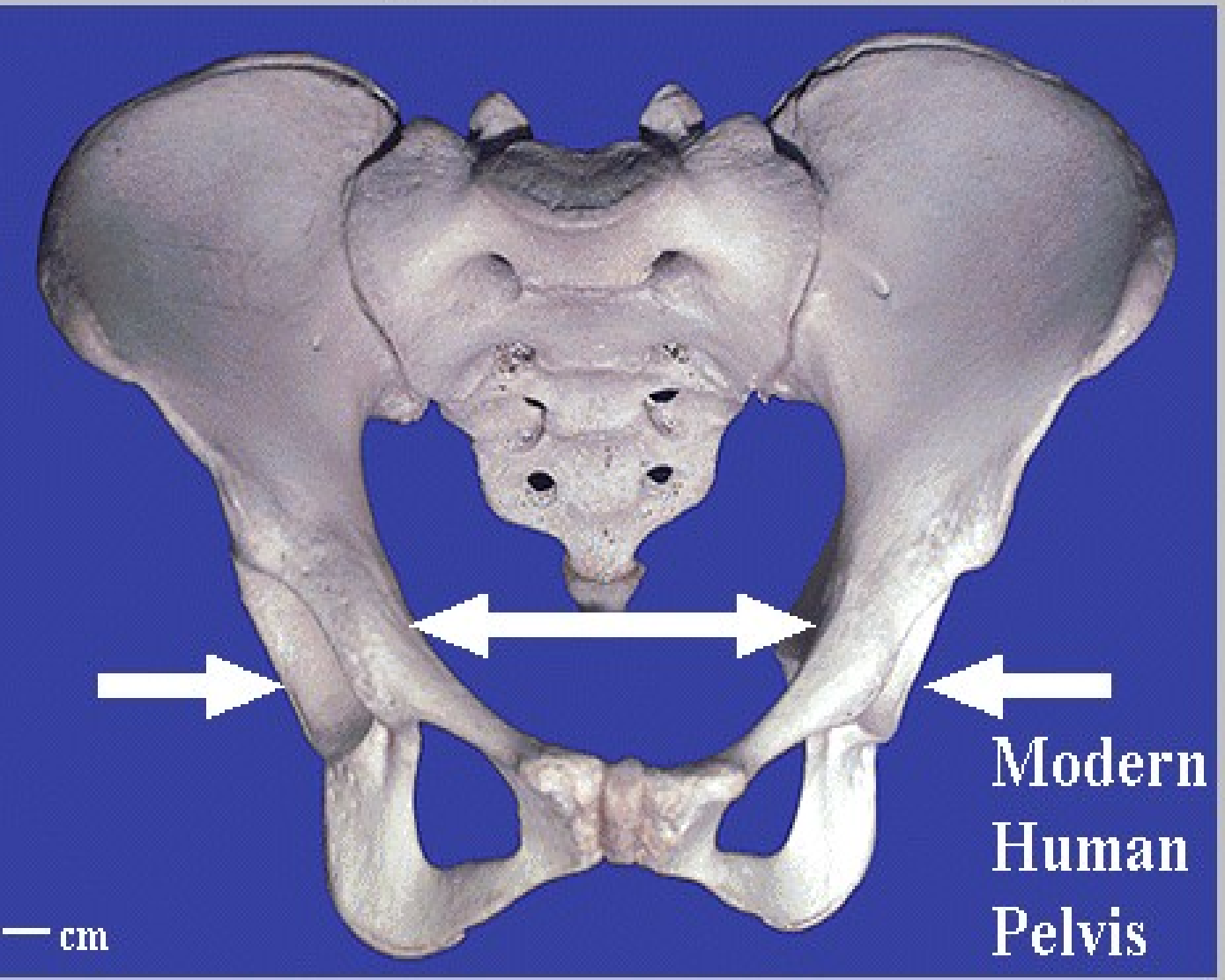


Although the exact function of its smaller gluteals is unknown, it is clearly the case that *Australopithecus* has an ala of the ilium that flares more **laterally** (to the side) than in *Homo*. This flare is a critical component of the lever system of the hip and acts to increase the mechanical advantage of the lesser gluteals by increasing their lever arm.

The green vertical lines mark the position of the hip joint and anterior point of the iliac ala, while the yellow arrows show how far the iliac ala flares past the hip joint. The australopithecine has about 2.5 times greater lateral flare than a modern human.

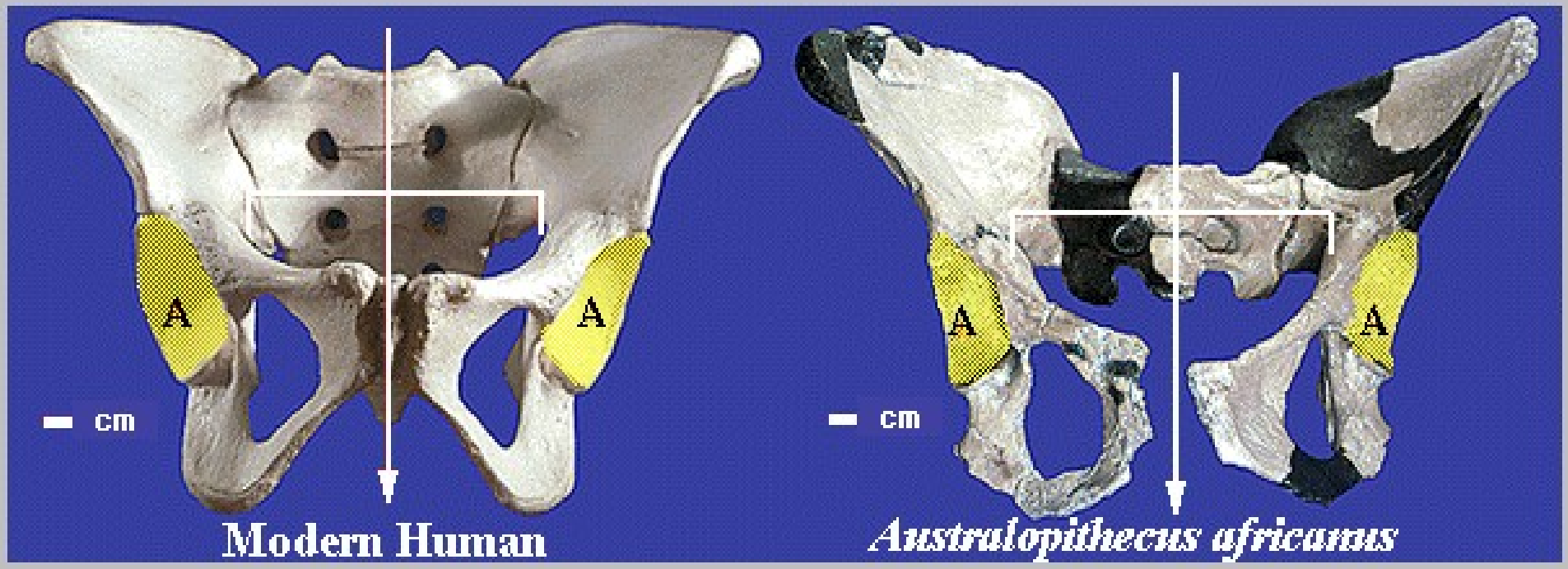

Cm

The modern human pelvis has even more widely spaced hip joints and a larger pelvic outlet relative to australopithecines. These differences appear to be a compromise between two functional needs: 1) efficient bipedality; and 2) allowing enough space for wide shouldered, large brained infants to pass through the birth canal.



What predictions can you make about the biomechanics of the pelvis, including the variables discussed on the previous page?

Press "Go to Next Page" to test your ideas.

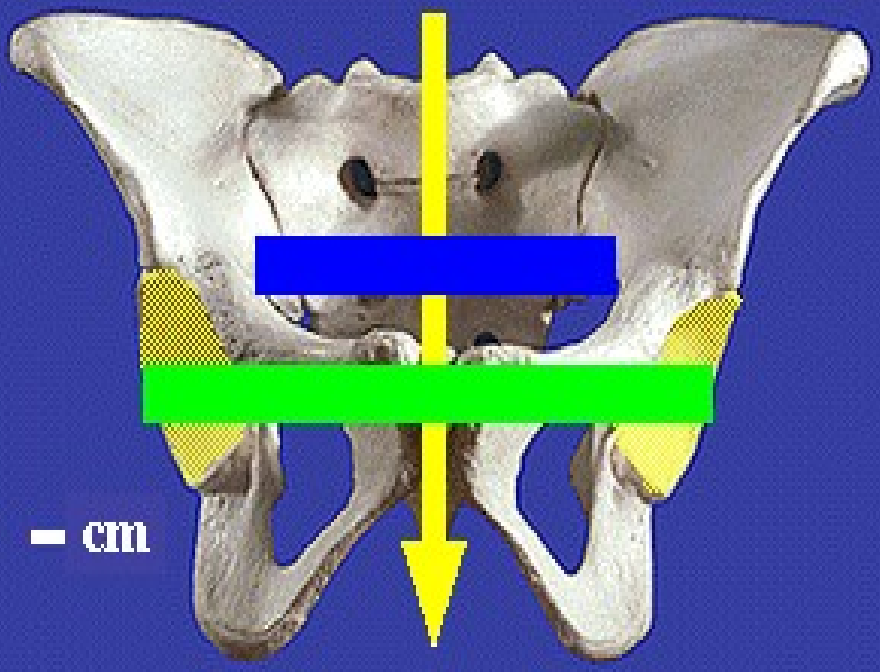


One consequence of the broader pelvic outlet in modern humans is the repositioning of the hip joint relatively further from the center line of the body than is seen in australopithecines. This is a critical adaptation because modern human babies are born with absolutely (and relatively) large brains; the big head must pass through the birth canal. Also note the larger size of the hip joint in humans. If the acetabulum ("A" above) is moved further away from the body's center of gravity, more force acts on the femoral head, and a head with a larger diameter helps to counteract these forces. (Also see the section in this lab on the femur.)

Click HERE for an explanatory page.

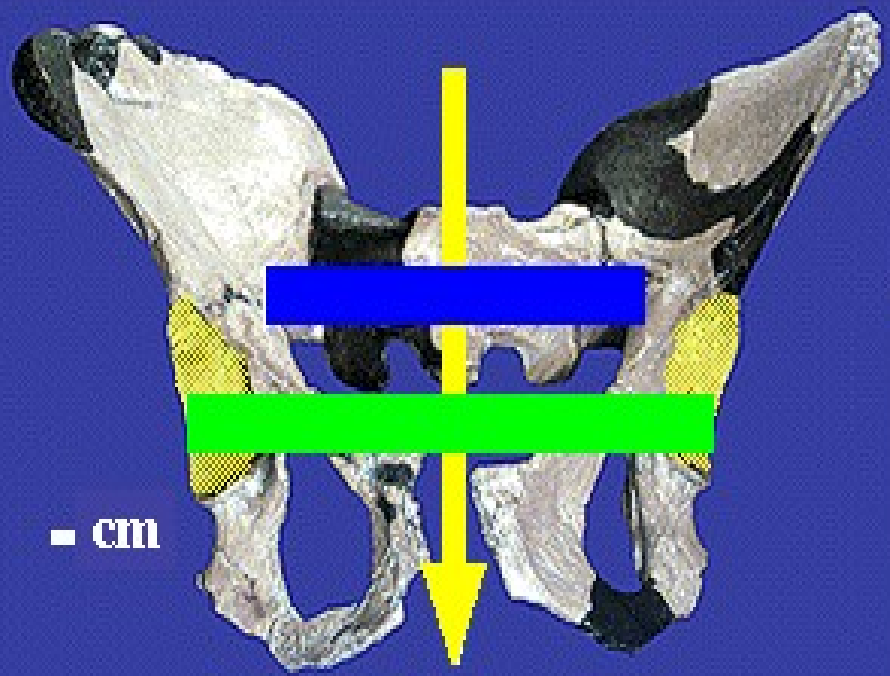
Centers of gravity are represented by vertical yellow arrows. Maximum width of the pelvic outlet is shown by a blue line. The green line is the maximum acetabular (hip joint) width. A comparison of the width ratio of pelvic outlet breadth to acetabular width illustrated at the bottom of the page shows that modern humans have relatively more widely spaced hip joints (smaller ratio) than australopithecines.

Modern human



– cm

Australopithecine

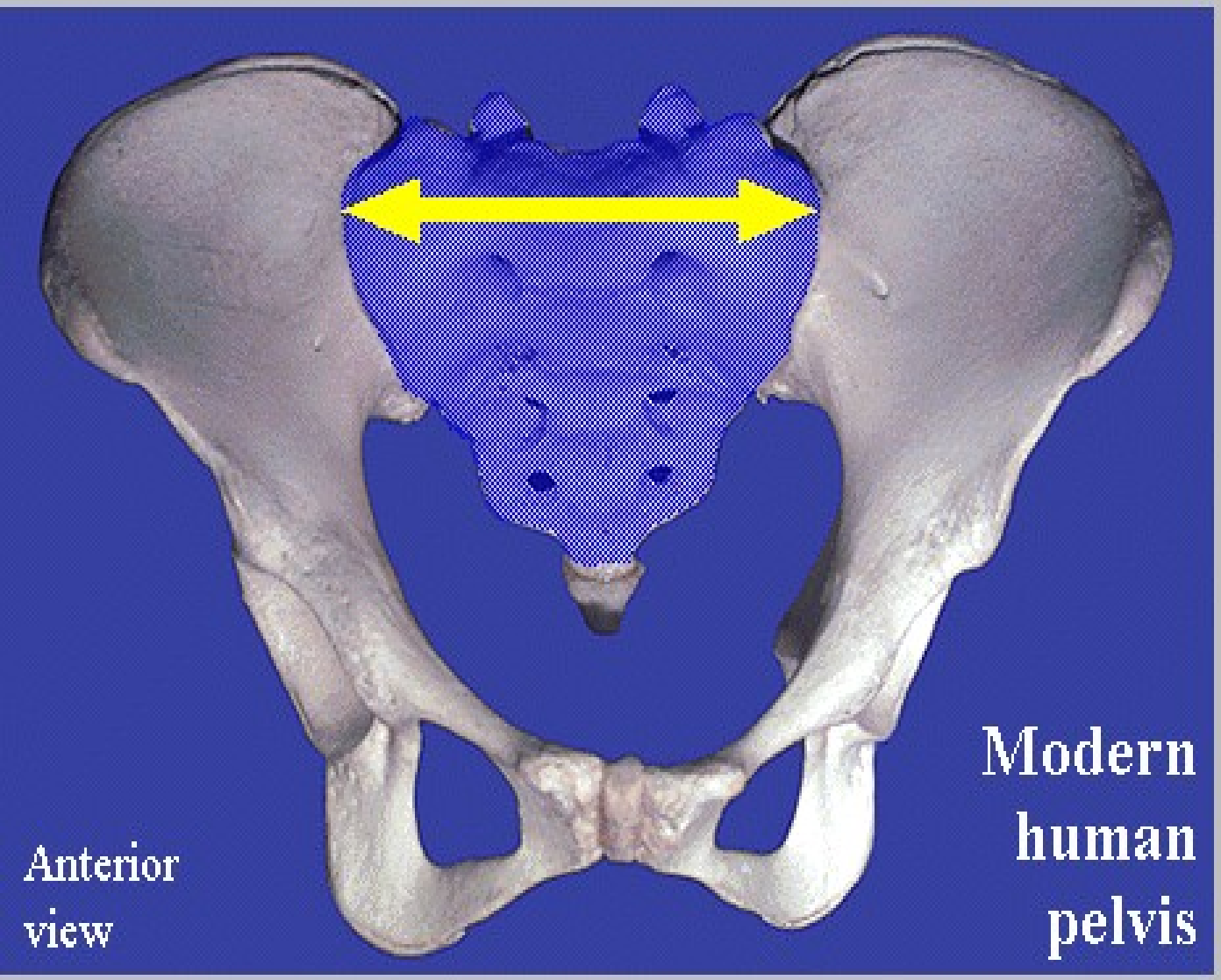


– cm

Width ratio: 0.625

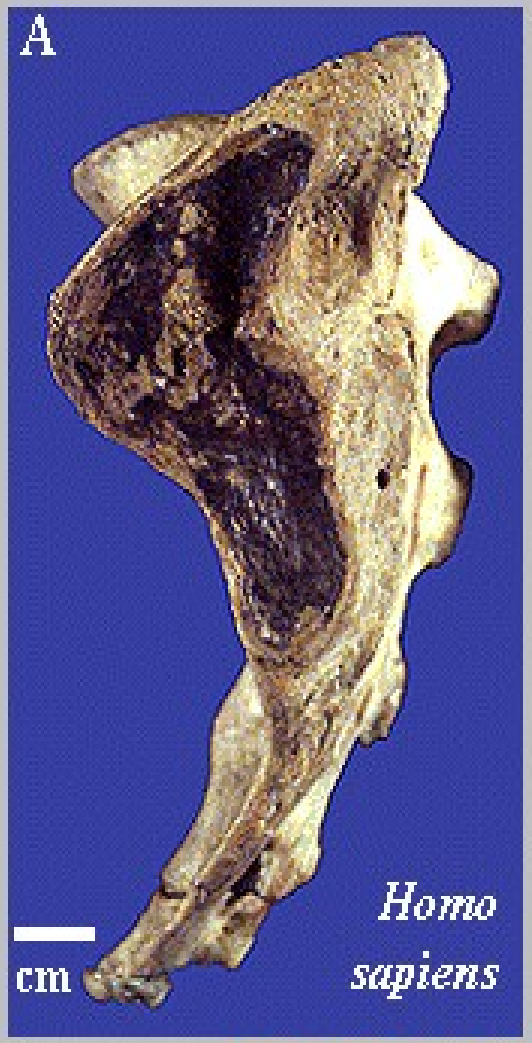
Width ratio: 0.71

Sacrum



Anterior view of the modern human pelvis showing the articulation between the left and right os coxae and the sacrum.

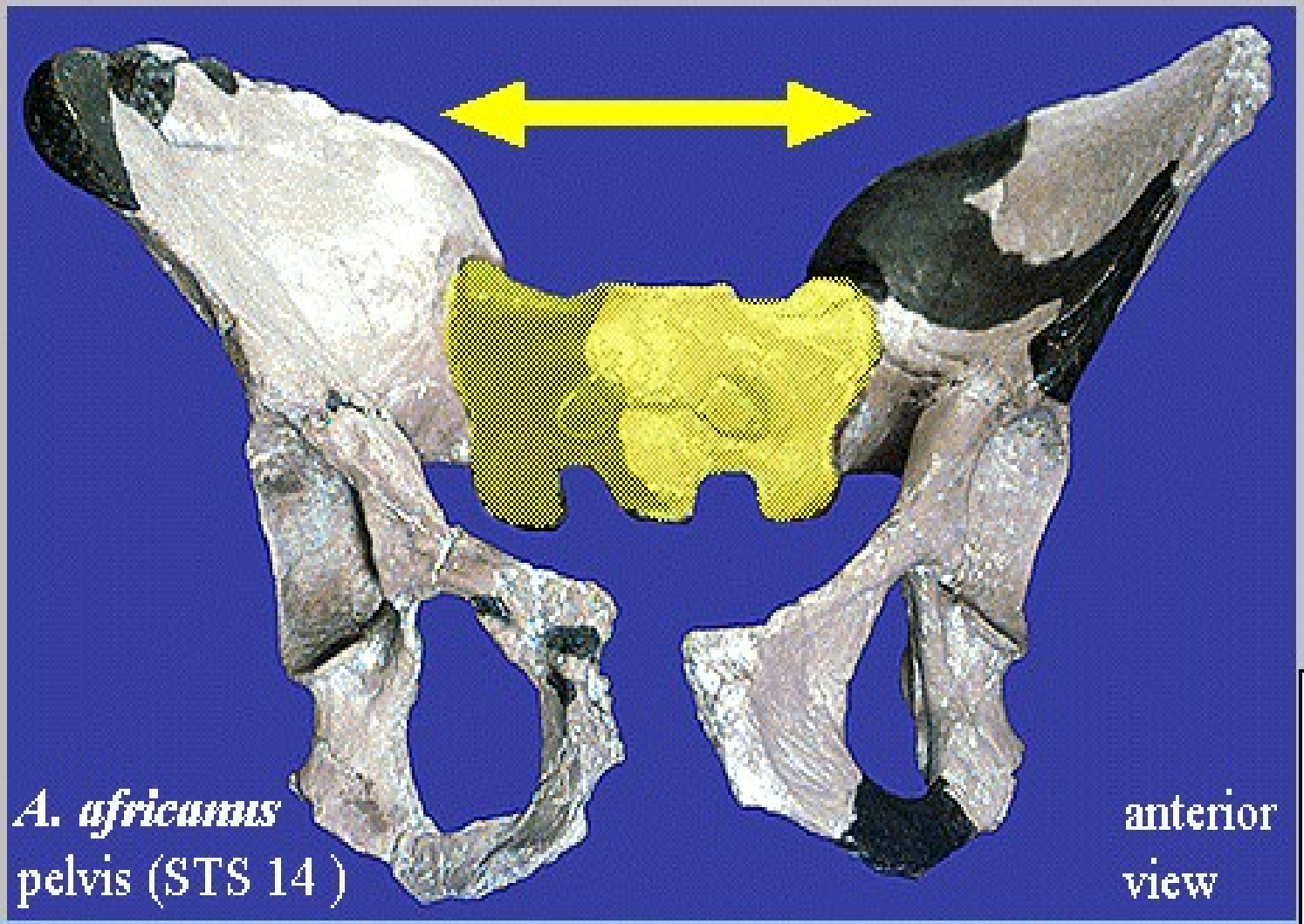
The sacrum is comprised of several fused vertebrae and articulates with both the last lumbar vertebra, and the pelvis at the sacroiliac joint. Note how broad the sacrum is in this modern human. The coccyx is composed of three to five rudimentary vertebrae.



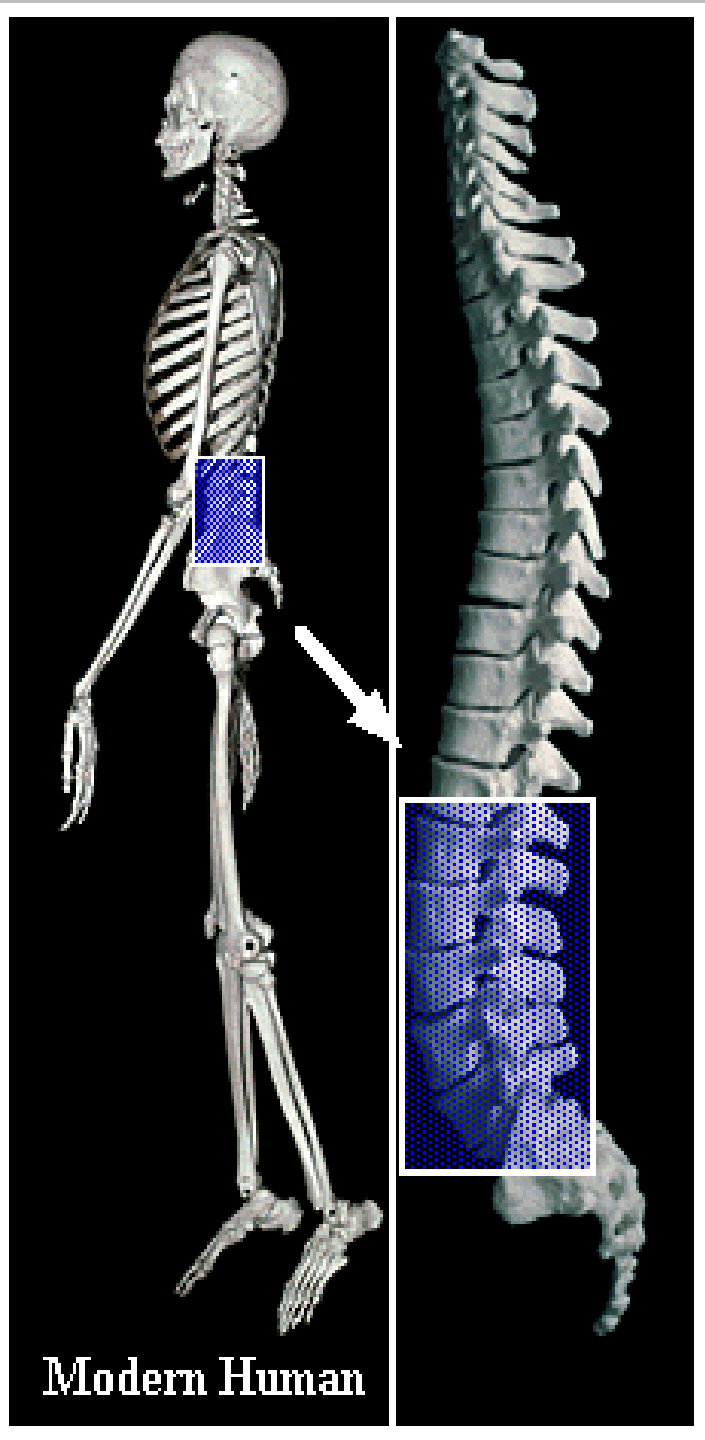
Left lateral views of male human (A), female *A. afarensis* (B; AL 288-1an), and male chimp (C) sacra.

The large sacroiliac joint surface in humans and the small joint surface in chimps is related to the different pattern of weight transmission through the pelvis seen in quadrupeds and bipeds. The shape of the sacroiliac joint also reflects the lumbar curve (curved in humans; straight in chimps). Note that the australopithecine sacrum has a large sacroiliac joint surface but is less curved.

Anterior view of partial sacrum and pelvis of *Australopithecus africanus*. Note that the right half of the sacrum in this specimen and some of the pelvis has been reconstructed (areas in black).



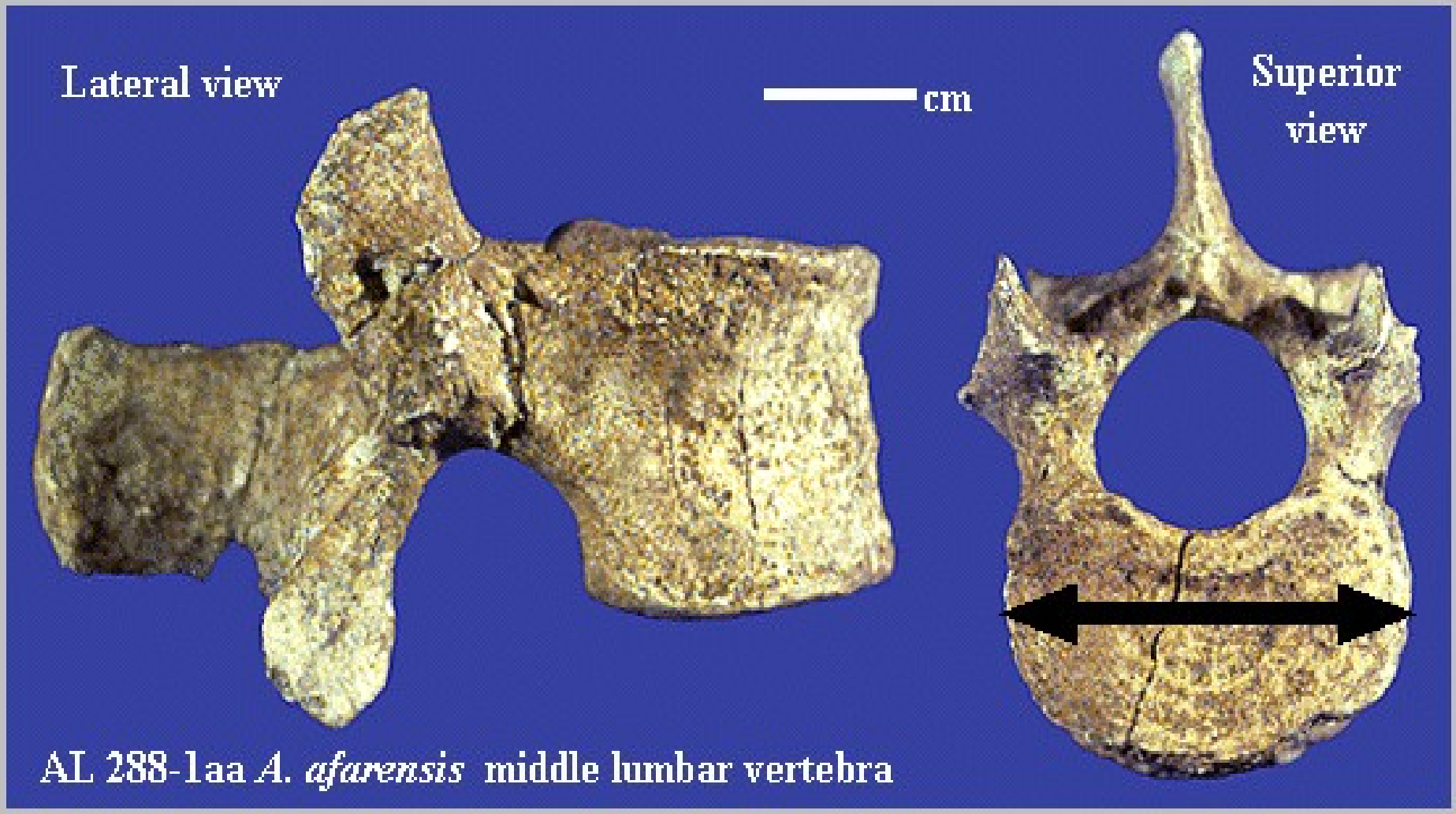
This australopithecine fossil (STS 14) is somewhat fragmentary, but does preserve a partial sacrum comprised of several fused vertebrae. Note that the australopithecine sacrum is **broad** and resembles the sacrum of modern humans. In contrast, quadrupeds generally have narrow sacra.



Lumbar Curvature

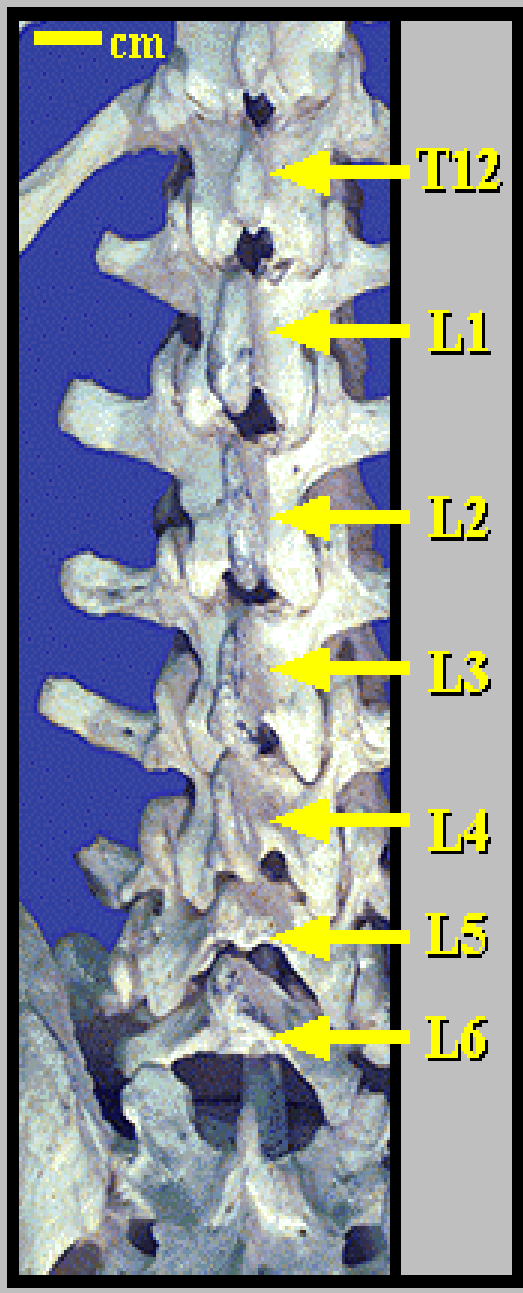
A biped is faced with many biomechanical problems that must be overcome in order to walk on two legs. One of the most critical issues is that of balance. The biped must lift one foot off the ground and swing it forward while balancing on the other foot.

Think of the selection pressures as operating to minimize the energetically costly movements of the center of gravity. **Lumbar curvature** helps to bring the center of gravity closer to the midline and above the feet. The increased number of lumbar vertebrae permits the hips and trunk to swivel forward. In the larger apes, the smaller number of lumbar vertebrae reduces the flexibility of the trunk. As a result, the hips must shift a greater distance with each step when an ape walks bipedally.



Australopithecine lumbar material is poorly known, but fragmentary remains from Lucy indicate that the lumbar **vertebral bodies** are **broad** for effective weight transmission from the upper body to the pelvis. Australopithecines had five or six lumbar vertebrae that articulate to form a distinctive lumbar curvature, similar to the morphology of modern humans.

Posterior views



The number of human lumbar vertebrae varies from four to six among different individuals, with vertebral column shown at left having the relatively common variant number of six (L1-L6). Most humans have five lumbar vertebrae. The last thoracic vertebra is shown as T12.

Homo sapiens

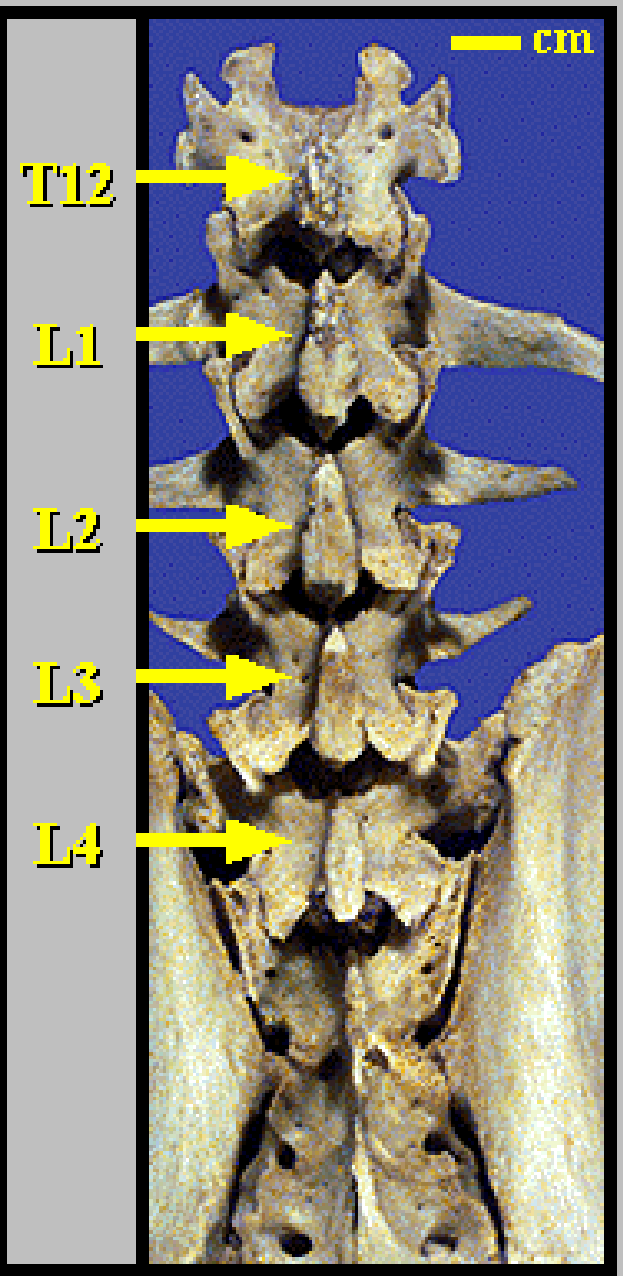
The lower back consists of the lumbar vertebrae, the sacrum, and the sacroiliac joint that forms the articulation between the vertebral column and the pelvis.

Humans and apes differ in their number of lumbar vertebrae. Humans usually have five lumbar vertebrae, while most large apes typically have four.

Human lumbar vertebrae are also larger in size, and this difference, along with the greater number, forms a lower back that permits more flexion of the trunk and hips when walking. The lower back of the apes is less flexible.

Posterior views

The number of lumbar vertebrae in the large hominoids (gorilla, chimp, and orangutan) varies from three to five, with four being the average among these three species. The chimp shown at right has four lumbar vertebrae. The last thoracic vertebra is shown as T12.



Pan troglodytes

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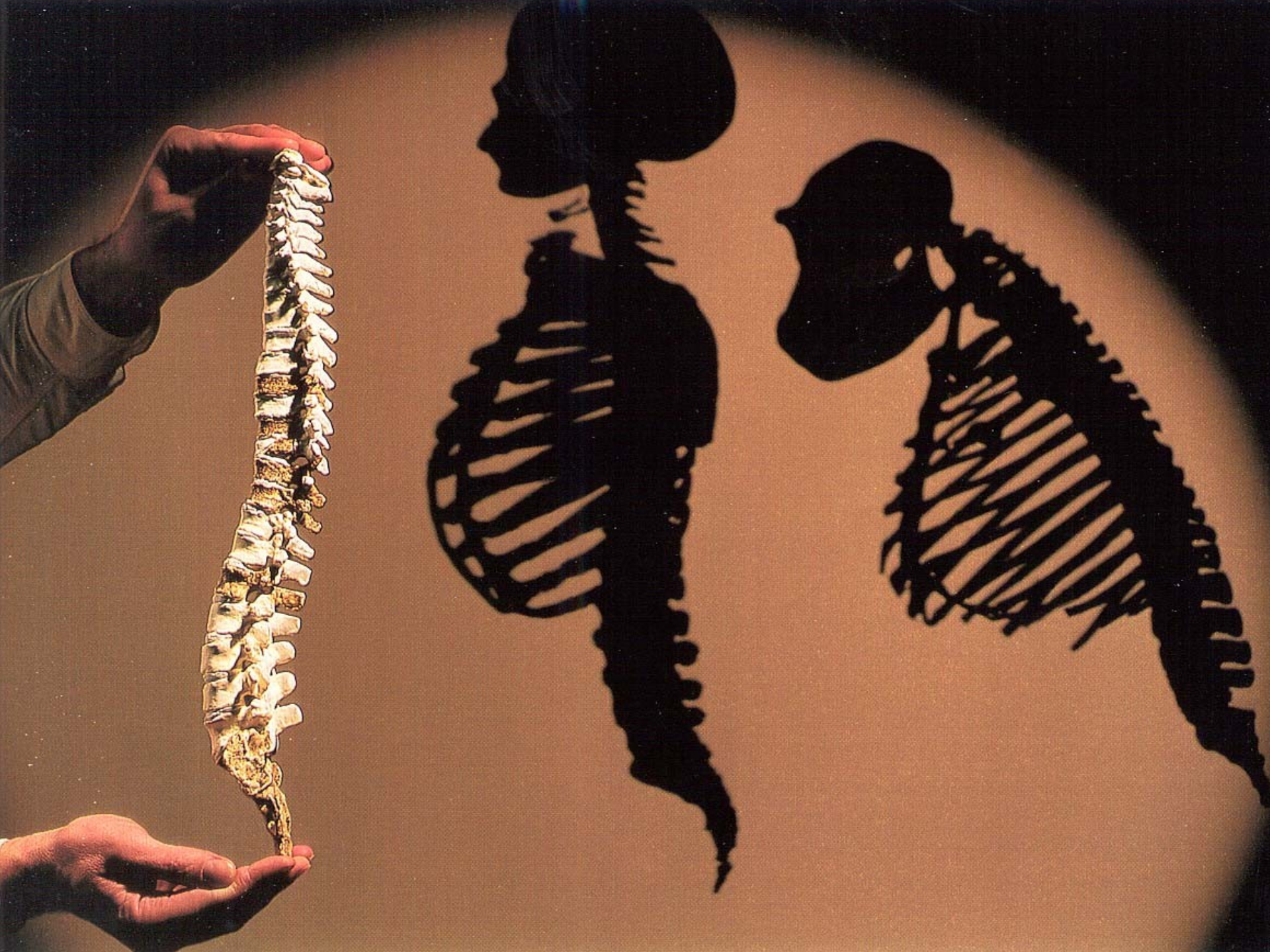
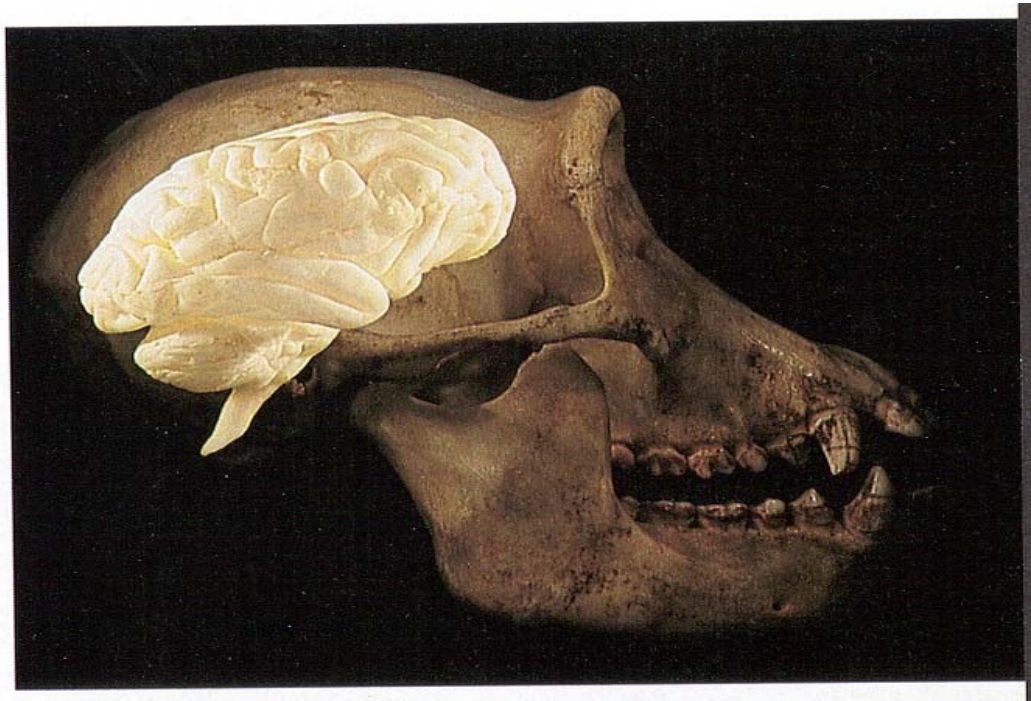
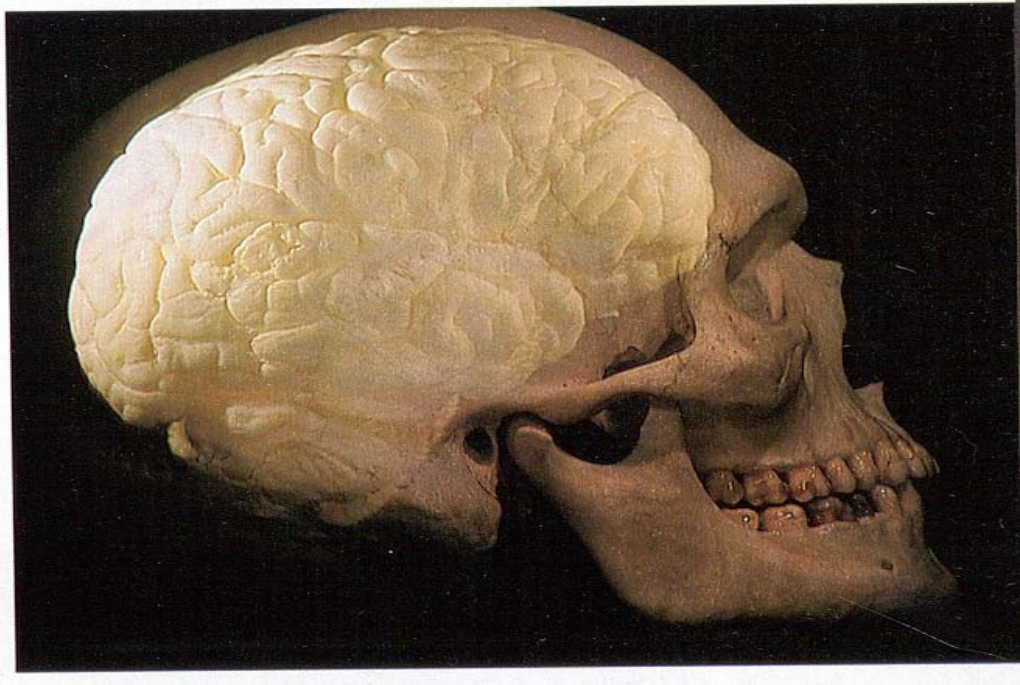


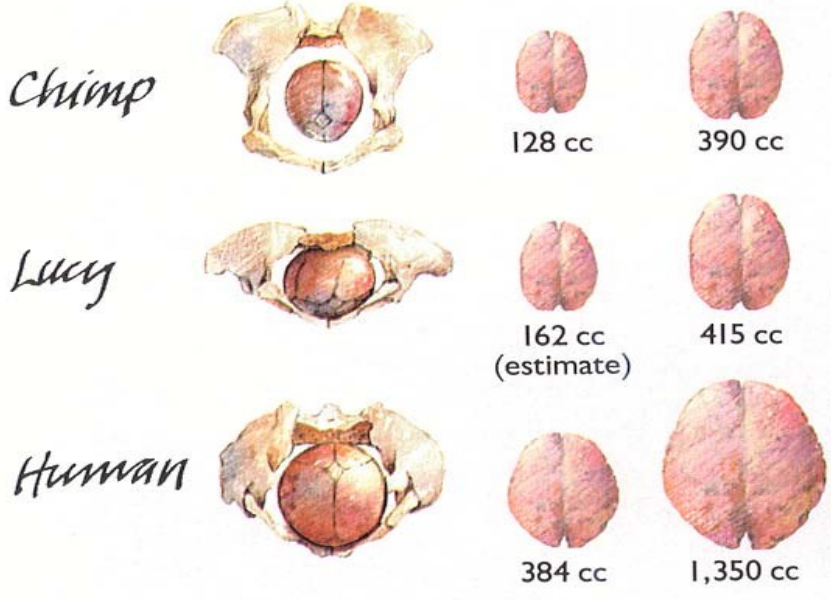
Brain space

Even the clever chimpanzee (right) seems small-brained next to a modern human (below right) in these images from a University of Zurich exhibit. The head of a baby chimp passes easily through the birth canal (diagram, below). In contrast, tremendous force is required to move a human infant's large head through its mother's narrow pelvis. Scientists speculate that *A. afarensis* females, such as Lucy, shared both conditions: They gave birth to small-headed infants, but the birth process was still difficult, because their pelvises were narrowed for upright posture.

AFTER ROBERT G. TAGUE AND C. OWEN LOVEJOY, *JOURNAL OF HUMAN EVOLUTION*, MAY 1986





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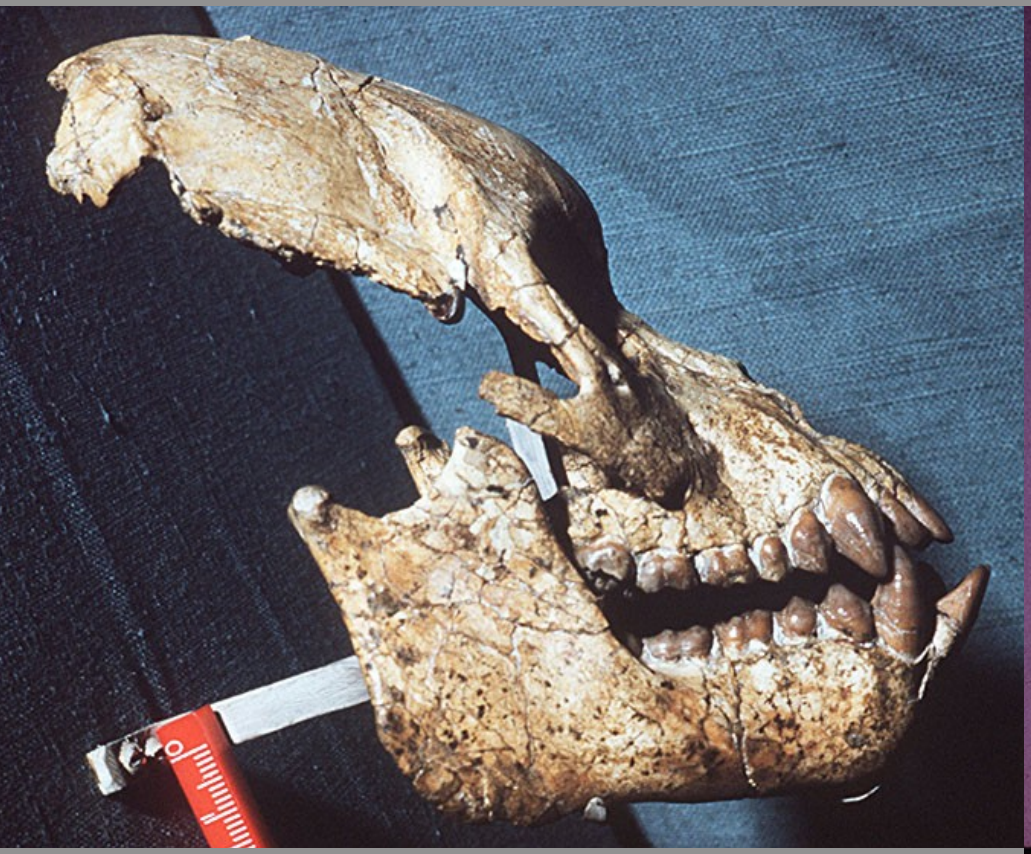
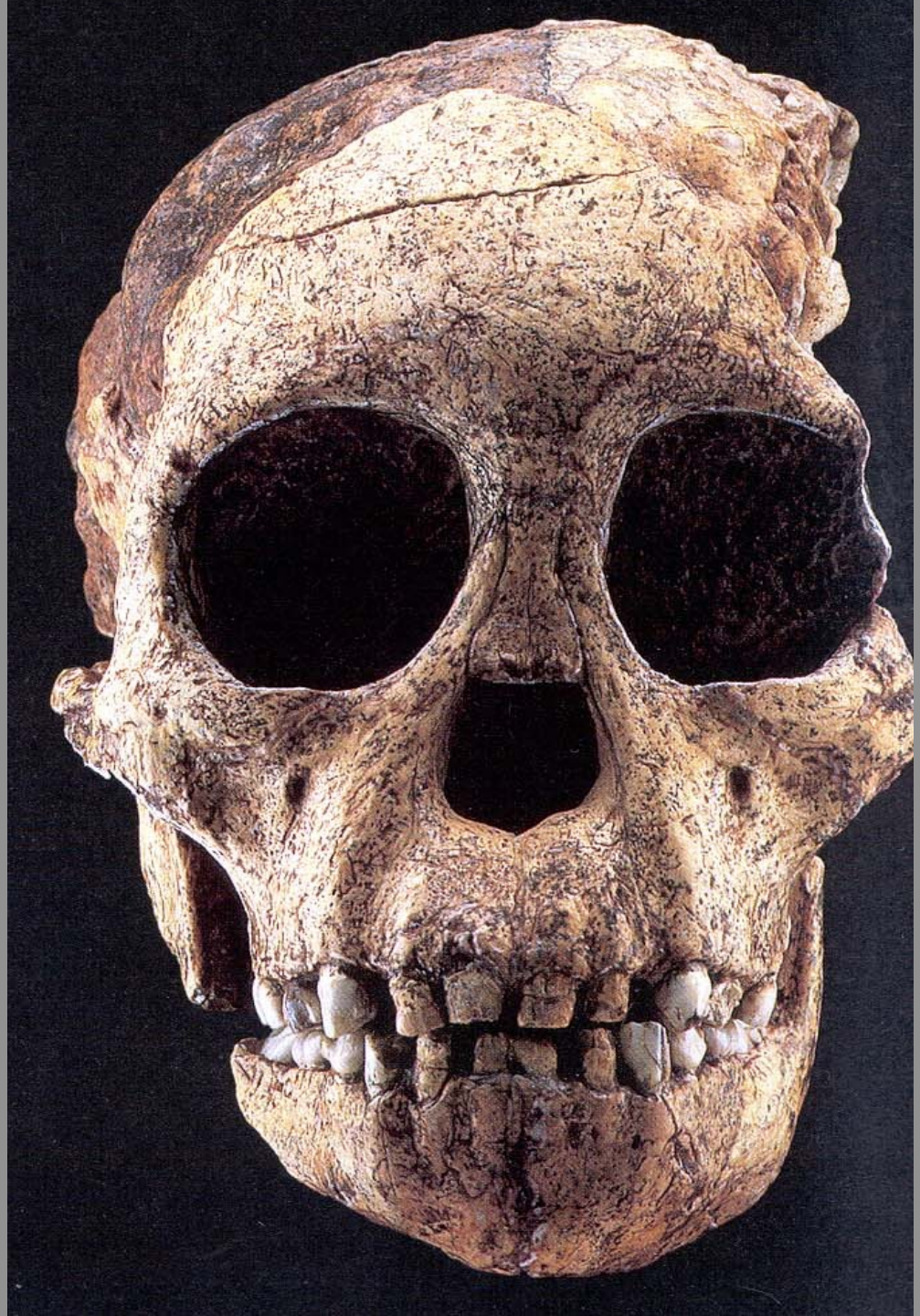


Skull of *Australopithecus africanus* from Taung, South Africa (see also page 143). If the famous Taung child matured at a rate similar to modern apes, then its estimated age at death was three years. This individual was probably preyed upon by an eagle. Actual size. *Photograph by David Brill; courtesy of University of the Witwatersrand.*



Brain space

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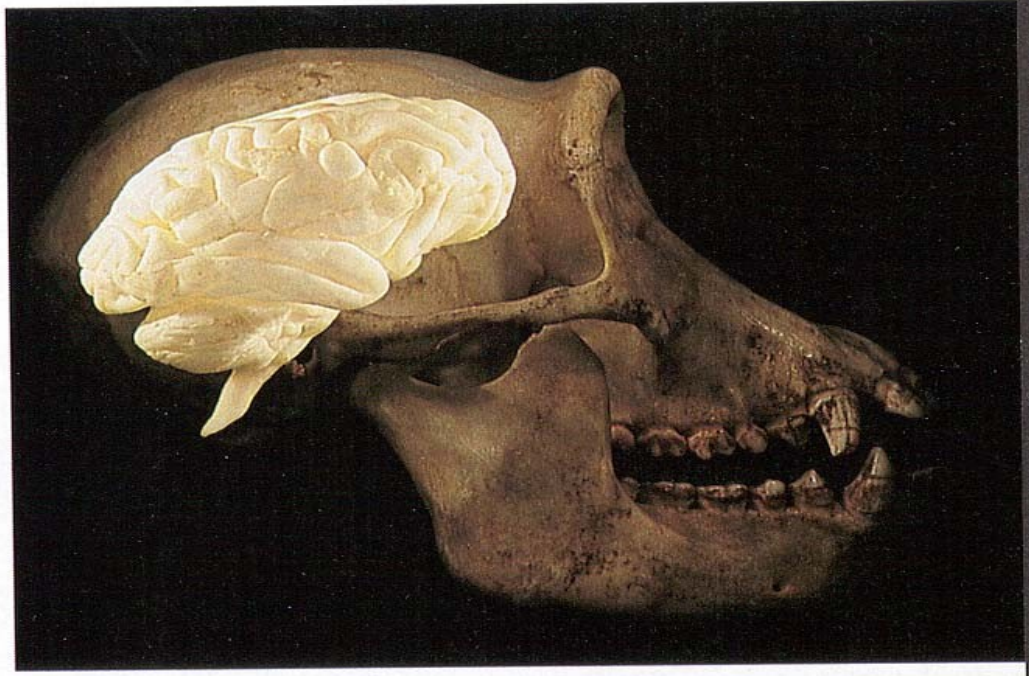

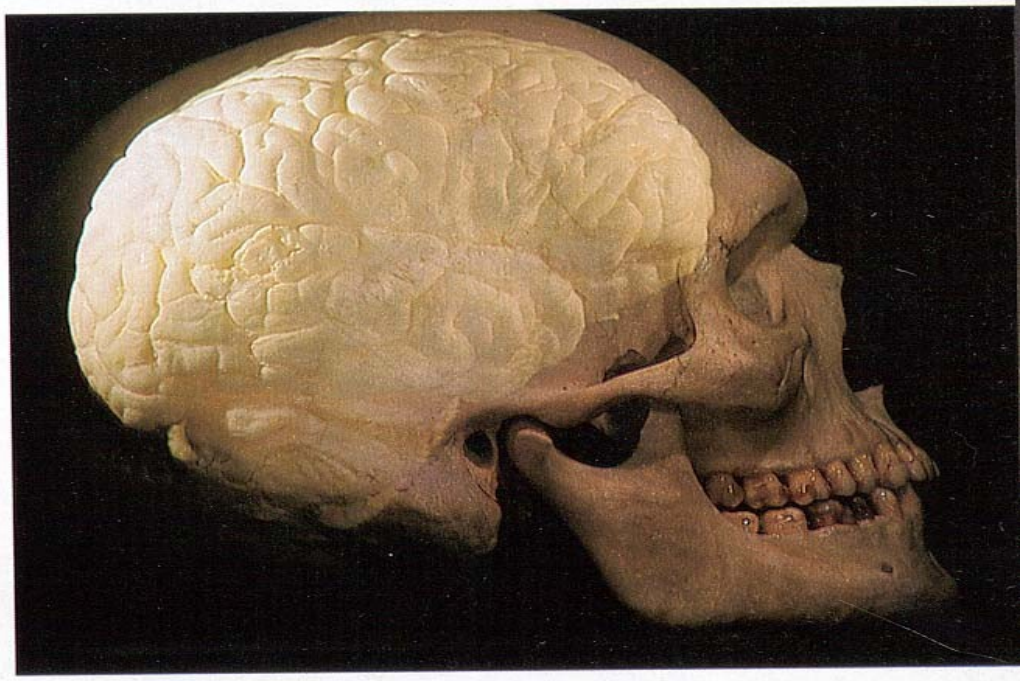

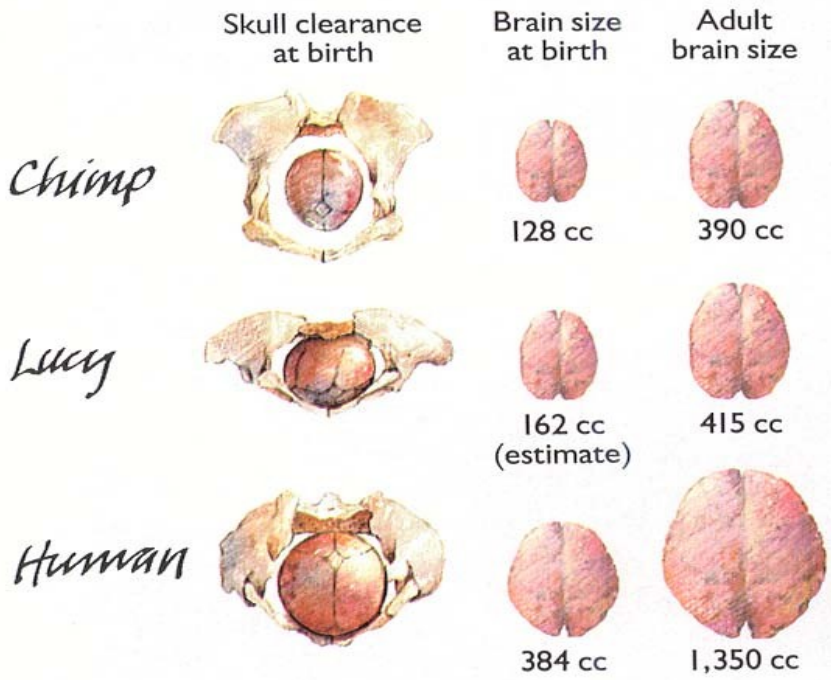


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